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THE EARLY WARNING AND MONITORING SYSTEM: A PROGRESS REPORT.(U)
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CRISIS MANAGEMENT PROGRAM

CYBERNETICS TECHNOLOGY OFFICE
DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
Office of Naval Research • Organizational Effectiveness Research Programs

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LEVEL II (4)

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THE EARLY WARNING AND MONITORING SYSTEM:
A PROGRESS REPORT

by

Judith Ayres Daly and Thomas R. Davies

Sponsored by

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SUMMARY

Introduction

This report documents and summarizes the progress which has been made toward the development of a Crisis Early Warning and Monitoring System. The work was conducted for the Defense Advanced Research Projects Agency's Cybernetics Technology Office.

Overview of problem. The Early Warning and Monitoring Project has been addressing several problems:

- the development, evaluation, and improvement of procedures for warning and monitoring of international security crises;
- the identification and observation of quantitative non-military indicators for crisis warning; and
- the integration of a variety of indicators and methods into an interactive, user-oriented, computer-based crisis warning system.

Research has resulted in significant progress on many aspects of these general problems. Furthermore, progress has revealed the importance of a new set of corresponding problems including:

- supplementing the crisis warning system with monitoring and retrieval systems;

- integrating the hardware, software, and methodologies of extant computer-based I&W systems; and
- implementing an efficient and effective transfer of the system to the user community.

Overview of solution. Many important aspects of the initial problem set have been resolved. For example, the number and nature of quantitative indicators for crisis warning and monitoring have been expanded and the indicators observed and tested. Additionally, the indicators and forecasting methods now reside in an interactive, computer-based system.

This research effort involved five different tasks:

- develop prototype system by adding indicators and exploring linkages with military indicator systems;
- test and evaluate prototype system's indicators, scans and forecasting methods, add data sets, and carry out real-time, off-line parallel testing;
- develop, document, and assist in transfer of interactive computer software;
- test and evaluate relationships between empirical methods and decision analytic methods of crisis warning; and
- explore integration of subjective and objective methods for crisis warning and management.

Progress on the Conceptual Design of a Fully Integrated Early Warning and Monitoring System

Interactions with potential users and research findings have resulted in substantial modifications to the original system design. The core components of the system--(1) quantitative crisis indicators; (2) quantitative indicators of U.S. interests abroad; (3) a forecasting capability; and (4) a computer base--are still very much in place. However, the emphasis placed on them has been modified by the needs

of potential users and by the addition of new conceptual components such as:

- general scans;
- current, regularly updated data;
- information retrieval and monitoring capabilities; and
- amalgamation with extant military indicators.

Progress on the Development of the Early Warning and Monitoring System

In addition to progress on and modifications to conceptual design, advances have been made on the development of crisis indicators, a forecasting capability, and a computer base.

Indicators. The original quantitative international political indicators, including levels of activity, tension, and uncertainty, continue to be modified and tested. Additionally, new indicators are being developed, including regional and systemic indicators as well as indicators developed in order to increase hit rates and lower false alarm rates.

Forecasting capability. New forecasting methods are now being developed. The current focus is on expanding the indicators with which forecasts can be made, developing new forecasting methods, and modifying techniques developed by others in preparation for integration into the system.

Computer base. The prototype's computer base is now supplied by DARPA/CTO's Development and Demonstration Facility (DDF). The computer base consists of an event data base, interactive software, a PDP 11/70 minicompter, Tektronix 4051 graphic terminals, and Tektronix 4631 hard copy units.

Testing of the Early Warning and Monitoring System

Extensive testing has been performed on all components of the Early Warning and Monitoring System. Such testing has been facilitated by the nature of the prototype's core data base--the DARPA-supported World Event Interaction Survey (WEIS). The data base now consists of over 100,000 non-routine international events for all counties in the world from 1966 to the present.

Political indicators. Indicators, probabilities, and thresholds have been tested over a large number of historical crises. Daily updating of the data is allowing the most crucial aspect of testing--real time monitoring and warning on a daily basis.

Military indicators. Preliminary testing of the synergism of extant military indicators with the political ones of the Early Warning and Monitoring System has begun. The focus of the tests has been on comparing the monitoring and warning performance of the two sets of indicators in historical crises.

Economic indicators. Acquisition of weekly economic data and OECD economic data have laid the groundwork for testing and development in this area.

Domestic indicators. Domestic indicators for potential integration into the Early Warning and Monitoring System are being developed and tested by other DARPA/CTO Crisis Management Program contractors.

Probabilities. Testing of the primary forecasting method of the warning system, associative generation of probabilities, has resulted in substantial modification of the method and greatly improved performance.

Demonstrating the Early Warning and Monitoring System

The master demonstration version of the Early Warning and Monitoring System remains extremely flexible, efficient, and user-oriented. The system now provides users with three types of output--tabular, graphic, and textual. Users can also rapidly retrieve and display crisis probabilities and indicators for all countries and regions.

Exploring Empirical Science/Decision Analysis Methodological Overlap

Research in this area has focused on comparing the performance of indicators developed with the two methodologies in historical crises and linking the different models, output, and technologies.

Future Research

Plans for future research center around expanding the information retrieval, warning, and monitoring components of the Early Warning and Monitoring System. Immediate plans call for enhancing the scanning capacity of the system, increasing the scope of the crisis indicators, and integrating complementary forecasts. New components such as an automatic warning and monitoring capability are also under consideration.

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ABBREVIATIONS

CIA: Central Intelligence Agency

COTR: Contracting Officer's Technical Representative

CTO: Cybernetics Technology Office

DARPA: Defense Advanced Research Projects Agency

DDF: Development and Demonstration Facility

DIA: Defense Intelligence Agency

DoD: Department of Defense

EFI: Event Frequency Indicators

EWAMS: Early Warning and Monitoring System

I&W: Indications and Warning

JCS: Joint Chiefs of Staff

MOU: Memorandum of Understanding

NMIC: National Military Intelligence Center

NYT: New York Times

OECD: Organization of Economic Cooperation and Development

ROZ: Row Percentages and Column Z-Scores

SALT: Strategic Arms Limitation Talks

TOL: Times of London

WEIS: World Event Interaction Survey

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THE EARLY WARNING AND MONITORING SYSTEM: A PROGRESS REPORT

1.0 INTRODUCTION

A substantial period of time has elapsed since the appearance of the last comprehensive statement of the purposes, design, methods, and findings of the Early Warning and Monitoring System (EWAMS) project (Andriole 1976a). This report documents the progress that has been made on the development, testing, evaluation, demonstration, and transfer of the prototype system in the interim and outlines what remains to be done.[1]

1.1 Overview of the Problem

The Early Warning and Monitoring System project initially addressed several problems:

- the development, evaluation, and improvement of procedures for warning and monitoring of international security crises;
- the identification and observation of quantitative non-military indicators for crisis warning;
- the integration of a variety of indicators and methods into an interactive, user-oriented, computer-based crisis warning system (Andriole, 1976a, 3-5).

Research over the past months has resulted in significant progress on many aspects of these general problems. Furthermore, as is usually the case, progress has revealed a new set of corresponding problems including:

[1] Dr. Judith Ayres Daly was with Decisions and Designs, Incorporated during the time period in which this research was performed.

- supplementing the warning system with monitoring and retrieval systems;
- integrating the hardware, software, and methodologies of extant computer-based Indications and Warning (I&W) systems;
- tailoring EWAMS to user needs; and, related to that,
- implementing an efficient and effective transfer of the system to the user community.

The somewhat altered focus of these new problems is not meant to imply that all the initial developmental and methodological questions have been answered. However, the shift in focus does suggest that progress both permits and demands renewed consideration of problems of purpose and transfer.

1.2 Overview of a Proposed Solution

Many important aspects of the initial problem set have been resolved. For example, the number and nature of quantitative indicators for crisis monitoring and warning have been expanded and the indicators observed and tested. Additionally, the indicators and forecasting methods now reside in an interactive, computer-based system.

Potential solutions to the new set of problems have been outlined. Strategies for successful conceptual and methodological transition from a monitoring to a warning system have been designed. Once this transition is made, users will be provided with three systems in one: systems for information retrieval, monitoring, and warning.

While integration of the hardware, software, and methodologies of extant I&W systems would greatly benefit the Intelligence Community, it is currently beyond our purview. However, conceptual integration is planned, since it will enhance the development and capabilities of EWAMS.

The Defense Advanced Research Projects Agency/Defense Intelligence Agency (DARPA/DIA) Memorandum of Understanding (MOU) of July 1977 has laid the groundwork for designing solutions to the problems of responding to user needs and transfer. In addition, interaction with DIA/NMIC (National Military Indications Center) personnel will greatly facilitate performance of the five FY 78 tasks specified in the EWAMS project proposal of June 1977. These tasks are:

- Develop prototype system by adding indicators and exploring linkages with military indicator systems.
- Test and evaluate prototype system's indicators, scans and forecasting methods, add data sets, and carry out real-time, off-line parallel testing at the direction of the Cybernetic Technology Office (CTO) and the Contracting Officer Technical Representative (COTR).
- Develop, document, and assist in transfer of interactive computer software.
- Test and evaluate relationships between empirical methods and decision-analytic methods of crisis warning.
- Explore integration of subjective and objective methods for crisis warning and management.

2.0 SUMMARY OF EFFORT

2.1 January 1976-September 1976

In broad summary, the first nine months of effort on what is now the Early Warning and Monitoring Prototype System resulted in:

- the design for a fully integrated crisis early warning system;
- preliminary development, testing, and demonstration of a prototype system based on a limited data set; and
- study of the feasibility of blending empirical and decision analytic methods.[1]

2.1.1 Initial design. The components of the design for a fully integrated system were:

- quantitative military, political, and economic crisis indicators;
- quantitative indicators of U.S. military, political, and economic interests abroad;
- a unified multi-method forecasting capability; and
- a computer base.

Crisis indicators. The range of crisis indicators in the initial design for the integrated system

[1]For details on these accomplishments see Appendix B (Managerial Memorandum #1, Research Memorandums #1-#4, and Technical Report 76-19).

included internal (domestic) and external (international and global) static and dynamic military, political, and economic indicators.

Indicators of U.S. national interests. The design also included quantitative indicators of U.S. national interests designed to yield insights into the nature and depth of U.S. interests abroad. These interests were classi fied as current, emerging, and potential and ranked on country-by-country and regional bases.

Unified multi-method forecasting capability. The unified multi-method forecasting capability required the system to generate different kinds of forecasts or warnings via different methods for different events and conditions. Such options were designed with reference to the objects, goals, and methods of forecasting.

Computer base. The system's computer base was to be capable of efficiently storing, retrieving, processing, and displaying large quantities of information. A computer base comprised of data, interactive software, and flexible hardware was envisioned for the integrated system.

Operation of the integrated crisis warning system. The integrated system was to enable a user to generate forecasts or warnings on regional, country-by-country, or national-interest bases. The initial design also permitted more specific, country-by-country scanning, as well as examination of specific indicators in the context of specific situations over varying periods of time.

2.1.2 Development, testing, and demonstration. In very brief summary, progress on the development, testing, and demonstration of the system through September 1976 can be stated as follows:

Development. In the last technical report, progress regarding the development of the prototype crisis early warning system was described in terms of the identification and specification of quantitative indicators for crisis warning, an associative forecasting capability, and a computer base.

Crisis indicators. Prototype indicators were political and dynamic, extracted from the international level of analysis, and developed with reference to international interaction. The specific indicators included levels of activity, tension, and uncertainty. Activity indicators reflected the total volume of events sent and/or exchanged, as well as the volume of cooperative and conflictual events. Tension levels reflected the mix of cooperative and conflictual events, while the uncertainty indicator measured the range of event types sent and/or exchanged.

Forecasting capability. The prototype was capable of forecasting international crises on a short-range, retrospective basis via an associative forecasting method, which, on the basis of past crisis behavior, generated monthly crisis probabilities.

Computer base. The prototype's computer base consisted of an events data base, interactive software, a PDP 11/70 minicomputer, Tektronix 4051 graphic terminals, and Tektronix 4631 hard copy units.

In order to test the ability of the quantitative political indicators to forecast international security crises, a number of decisions had to be made regarding the selection of an appropriate data base, the selection of test cases (nations and crises), and the nature of the tests.

Data base. The event data base of the ARPA-supported World Event Interaction Survey (WEIS) was selected for test purposes. This data set consisted of 90,000 non-routine international events for the period 1966 to 1975. The actors in the WEIS data base and their three-letter system names are given in Figure 2-1.

Test cases. Several crisis chronologies yielded a preliminary test set consisting of three crises: (1) the January 1967 Sino-Soviet border clash; (2) the August 1968 Czechoslovakian invasion; and (3) the November 1971 Indo-Pakistani war. In addition to these crises, a fourth, non-crisis case was examined in order to comparatively determine the possible uses of the indicators in non-crisis situations. The case selected was U.S./U.S.S.R. dyadic relations, examined on a quarterly basis, for the ten-year, 1966-1975 period.

Nature of preliminary test. Since the data base consisted of events initiated and received over a ten-year period, the preliminary tests were necessarily retrospective. However, the tests were designed to simulate crisis forecasting and general tracking as they might have been conducted had such capabilities existed during the 1967, 1968, 1971 monthly pre-crisis periods, and the 1966-1975 quarterly periods.

Test results. Analysis of the three crisis and one non-crisis periods revealed that the use of quantitative political indicators of activity, tension, and uncertainty would have significantly improved the defense community's ability to forecast the crises and interpret the nature and direction of the relations between the U.S. and the U.S.S.R.[2] The crisis probabilities generated from the indicators all rose steadily on the average of three months prior to the outbreak of the crises. Indeed, the tests suggested that

[2]For detailed analysis of these results, see Andriole (1976a):37-54.

700	AFG	Afghanistan
339	ALB	Albania
615	ALG	Algeria
232	AND	Andorra
561	ANG	Angola
160	ARG	Argentina
900	AUL	Australia
305	AUS	Austria
695	BAH	Bahrain
053	BAR	Barbados
765	BGD	Bangladesh
211	BEL	Belgium
266	EBE	Berlin/East
267	WBE	Berlin/West
760	BHU	Bhutan
476	BIA	Biafra
145	BOL	Bolivia
571	BOT	Botswana
140	BRA	Brazil
355	BUL	Bulgaria
775	BUR	Burma
516	BUI	Burundi
811	CAM	Cambodia
471	CAO	Cameroun
020	CAN	Canada
431	CPV	Cape Verde
482	CEN	Central Africa Rep.
780	CEY	Sri Lanka (Ceylon)
483	CHA	Chad
155	CHL	Chile
710	CHN	China, Peoples Rep.
713	CHT	China, Republic of
100	COL	Columbia
495	COM	Comoro Islands
484	CON	Congo Brazzaville
490	COP	Zaire (Congo-Kinshasa)
094	COS	Costa Rica
040	CUB	Cuba
352	CYP	Cyprus/Greek
353	CYT	Cyprus/Turkish
315	CZE	Czechoslovakia
434	DAH	Dahomey
390	DEN	Denmark
042	DOM	Dominican Rep.
130	ECU	Ecuador
092	ELS	El Salvador
440	GUE	Equitorial Guinea
531	ELF	Eritrean Liberation Front
530	ETH	Ethiopia
375	FIN	Finland
220	FRN	France
980	FIJ	Fiji
555	FRE	Frelimo-Mozambique Liberation Org.
481	GAB	Gabon
420	GAM	Gambia
265	GME	Germany/Dem. Rep.
255	GMW	Germany/Fed. Rep.
452	GHA	Ghana
350	GRC	Greece
090	GUA	Guatemala
438	GUI	Guinea
441	GBI	Guinea-Bissau
110	GUY	Guyana
041	HAI	Haiti
091	HON	Honduras
310	HUN	Hungary
720	HOK	Hong Kong
395	ICE	Iceland
750	IND	India
850	INS	Indonesia
630	IRN	Iran
645	IRQ	Iraq
205	IRE	Ireland
666	ISR	Israel
325	ITA	Italy
437	IVO	Ivory Coast
051	JAM	Jamaica
740	JAP	Japan
663	JOR	Jordan
501	KEN	Kenya
731	KON	Korea/North
732	KOS	Korea/South
641	KUR	Kurdistan
690	KUW	Kuwait
812	LAO	Laos
660	LEB	Lebanon
570	LES	Lesotho
450	LBR	Liberia
620	LBY	Libya
223	LIC	Liechtenstein
212	LUX	Luxemburg
721	MAC	Macao
580	MAG	Malagasy
553	MAW	Malawi
820	MAL	Malaysia
782	MAD	Maldive
432	MLI	Mali
338	MLT	Malta
435	MAU	Mauritania
590	MAR	Mauritius
070	MEX	Mexico
221	MOC	Monaco
712	MON	Mongolia
600	MOR	Morocco
698	MOM	Muscat and Oman
562	NMB	Namibia (Former South-West Africa)
921	NAU	Nauru
790	NEP	Nepal
210	NTH	Netherlands
920	NEW	New Zealand
093	NIC	Nicaragua
436	NIR	Niger
475	NIG	Nigeria
385	NOR	Norway
770	PAK	Pakistan
095	PAN	Panama
905	PAP	Papua New Guinea
150	PAR	Paraguay
135	PER	Peru
840	PHI	Philippines
290	POL	Poland
235	POR	Portugal
485	STV	Principee & Sao Tomee
696	QAT	Qatar
552	RHO	Rhodesia
360	RUM	Rumania
517	RWA	Rwanda
331	SAN	San Marino
670	SAU	Saudi Arabia
433	SEN	Senegal
451	SIE	Sierra Leone
830	SIN	Singapore
520	SOM	Somalia
560	SAF	South Africa
681	SYE	South Yemen
230	SPN	Spain
780	CEY	Sri Lanka (Ceylon)
625	SUD	Sudan
105	SUR	Surinam
572	SWA	Swaziland
380	SWD	Sweden
225	SWZ	Switzerland
652	SYR	Syria
510	TAZ	Tanzania
800	TAI	Thailand
861	TIB	Tibet
461	TOG	Togo
052	TRI	Trinidad-Tobago
616	TUN	Tunisia
640	TUR	Turkey
500	UGA	Uganda
365	USR	USSR
675	UAE	United Arab Emirates
651	UAR	UAR (Egypt)
200	UNK	United Kingdom
002	USA	USA
439	UPP	Upper Volta
165	URU	Uraguay
328	VAT	Vatican
101	VEN	Venezuela
816	VTN	Vietnam/North
817	VTS	Vietnam/South
990	WSM	Western Samoa
678	YEM	Yemen
681	SYE	Yeman/South
345	YUG	Yugoslavia
490	COP	Zaire (Congo-Kinshasa)
551	ZAM	Zambia
554	ZIM	Zimbabwe-Rhodesia Liberation Org.

NON-GOVERNMENTAL ACTORS

198	AFP	Alliance for Progress
699	ARL	Arab League
692	OAP	Organization of Arab Petroleum Exporting Countries
693	OPC	Organization of Petroleum Exporting Countries
397	EEC	EEC
398	EFT	EFTA
396	NAT	NATO
199	OAS	OAS
599	OAU	OAU
697	PLO	Palestinian Liberation Organization
992	SEA	SEATO
818	VCG	Vietcong and NLF
394	WAR	Warsaw Pact
399	UNO	Any Intl. Org. (UN)
999	MLG	Any Multilateral Grp.
999	NSC	Not Stated, Unidentified Target
813	LAP	Pathet Lao

Figure 2-1

ALPHABETICAL LISTING OF WEIS COUNTRY CODES

quantitative political indicators could be used independently or in conjunction with other quantitative (military and economic) indicators.

Analysis of U.S.-U.S.S.R relations suggested that the indicators could be used for other, non-forecasting purposes. Specifically, a ten-year quarterly analysis revealed that activity, tension, and uncertainty increased and decreased at various times, apparently in response to specific events and conditions. Accordingly, the indicators might enable analysts to engage in what may be described as aftermath analysis, that is, assessment of the impact of various events and conditions upon selected patterns of international relations.

Demonstrating the Crisis Early Warning Prototype System. The prototype crisis warning system was geared to the development of a fully integrated crisis warning system and to how such a system might function in an applied mode. The demonstration prototype system was thus designed with user appeal and ease of operation in mind. The demonstration system, comprised of information storage, retrieval, processing, and tabular and graphic display capabilities, operated in a rapid and flexible manner. A user could access the system and derive crisis probabilities on a number of levels. In addition, a user had the option of retrieving the components of the probabilities via displays of one or more of the political indicators.

2.1.3 Exploring empirical science/Bayesian decision analysis methodological overlap. The empirical science/Bayesian decision-analytic methodological overlap was identified on four separate planes. It was suggested that quantitative empiricists could cooperate with decision analysts regarding the generation of indicators, the subjective and objective evaluation observation of indicators,

the generation and use of utilities, and the use of hierarchical inference structuring for generalized and case-study crisis modeling.

2.2 September 1976-March 1978

The last eighteen months have resulted in considerable progress in all these areas. This progress, briefly summarized here, is reported in detail in Sections 3.0-6.0.

2.2.1 Progress on the conceptual design of a fully integrated early warning and monitoring system. The combination of interaction with potential users of the system and research findings has resulted in substantial modifications to system design. The core components of the system--(1) quantitative military, political, and economic crisis indicators; (2) quantitative indicators of U.S. military, political, and economic interests abroad; (3) a unified multi-method forecasting capability; and (4) a computer base--are still very much in place. However, the emphasis placed on them has been modified by needs of potential users and by the addition of new conceptual components.

The warning/monitoring feedback loop. System design has been influenced and clarified by a clearer conceptualization of the relationship between monitoring and warning processes. Two components of monitoring and warning are receiving a great deal of attention: indicator thresholds and the requirement for current data. Strictly speaking, thresholds are not a new system component but their importance has been greatly increased by two concerns: (1) requirements of the user community, and (2) the need to successfully make the transition from a monitoring to a warning system. For EWAMS to be useful in an operational environment, its indicators must be based on current and regularly updated data. This requirement has influenced the

amount of attention we have devoted to developing indicators included in the original design of a fully integrated crisis early warning system.

General scans. General scans, i.e., tracking groups of countries defined by criteria of user interest, are designed to enhance analyst efficiency.

Three systems in one. Clarification of the relationship between warning and monitoring processes has resulted in a qualitative change in the initial design of the system. The change, designated by the term "three systems in one," recognizes that a system which simply forecasts, or warns of crises, is insufficient. EWAMS is now comprised of information retrieval, monitoring, and warning systems. As discussed below, there are advantages and disadvantages to this new approach.

Amalgamation with extant indicator systems. It would be more cost effective to amalgamate extant I&W systems rather than to construct a new one from the ground up.

2.2.2 Progress on the development of the Early Warning and Monitoring System. In addition to progress on and modifications to conceptual design, advances have been made on the development of indicators, forecasting capability, and computer base.

Indicators. Not only have the original quantitative international political indicators been modified and tested, but new ones are being developed. These include regional and systemic indicators as well as indicators developed in order to increase hit rates and lower false alarm rates.

Forecasting capability. Forecasting methods other than those currently in the system are being developed.

The focus is on expanding the numbers of indicators with which forecasts can be made, developing new forecasting methods, and modifying techniques developed by others in preparation for integration into the system.

Computer base. The prototype's computer base is now supplied by ARPA/CTO's Development and Demonstration Facility (DDF) (Wittmeyer 1978).

2.2.3 Testing of the Early Warning and Monitoring System.

Political indicators. Extensive testing has been performed on all components of EWAMS. Such testing has been facilitated by the nature of the prototype's core data base--the ARPA-supported World Event Interaction Survey (WEIS). WEIS now consists of over 100,000 non-routine international events for all countries in the world from 1966 to the present. The nature of the data base has permitted testing of indicators, probabilities, and thresholds over a large number of historical crises. Daily updating of the data has just begun and is allowing the most crucial aspect of testing--real-time monitoring and warning on a daily basis.

Military indicators. Under the terms of the ARPA/DIA Memorandum of Understanding, preliminary testing of the synergism of extant military indicators with the political ones of EWAMS has begun. The focus of the tests has been on comparing the monitoring and warning performance of the two sets of indicators in historical crises.

Economic indicators. Acquisition of the CIA Weekly Economic Indicator data and the Organization of Economic Cooperation and Development (OECD) economic data has laid the groundwork for testing in this area.

Domestic indicators. The University of Maryland's Cross-National Crisis Indicators Project is developing and testing domestic indicators for potential integration into EWAMS.

Probabilities. Testing of the primary forecasting method of EWAMS, associative generation of probabilities, has resulted in substantial modification of the method and greatly improved performance.

National interests. Testing of national interest indicators and scans has been facilitated by acquisition of the findings and data of the National Interests and Early Warning Project. This project, designed specifically to support EWAMS, has been completed. However, since the data are not being kept current, integration of national interest indicators and scans into the master demonstration system remains uncertain. On-going testing of the national interest work should help ARPA/CTO evaluate the utility of a renewed effort in this area.

2.2.4 Demonstrating the Early Warning and Monitoring System. The master demonstration version of the EWAMS is now in its third generation.[3] The master version is the focus of on-going research and development but at the same time, it remains extremely flexible, efficient, and user-oriented. (A partial list of those who have viewed the demonstration is provided in Appendix C.) In addition, provision of a Tektronix 4051 (which permits display of both graphic and tabular output of EWAMS) to DIA/NMIC has permitted many informal demonstrations of the system's capabilities and allowed DIA analysts to experiment at their leisure.

[3]For documentation of the earlier "Historical" and "Real-Time" versions, see DDI (1978).

2.2.5 Exploring empirical science/decision analysis methodological overlap. Exploration of the empirical science-decision analysis blend has been primarily centered at the NMIC where decision-analytic models for I&W are being used. Research has focused on

- comparing the performance of indicators developed with the two methodologies in historical cases; and
- linking the different models, output, and technologies of the two methodologies.

3.0 DESIGN OF A FULLY INTEGRATED EARLY WARNING AND MONITORING SYSTEM

The combination of research findings and interaction with potential users has resulted in valuable modifications to the initial design of a fully integrated system. The key components of the system--

- quantitative military, political, and economic indicators for monitoring and warning;
- quantitative indicators of U.S. national interests abroad;
- a unified multi-method forecasting capability; and
- a computer base--

are still in place.

However, the relative emphasis placed on the components has been modified by needs of potential users and a more complete understanding of the warning problem. Consideration of these two factors has resulted in conceptual and operational additions of new components, as well as in the expansion of potential functions of EWAMS. Consequently, a qualitative change in the design of EWAMS has evolved. In the original system design, the emphasis was almost solely on forecasting or warning of international crises. However, warnings without context have little meaning. Context must be provided by monitoring and information retrieval systems. New components of the EWAMS design, both conceptual and actual, include:

- the monitoring/warning feedback loop;
- general scans;

- amalgamation with extant indicator systems;
- "intelligent I&W;" and
- conceptual integration of I&W and operations processes.

Expansion of the system's potential functions suggests that EWAMS can serve as three systems in one:

- an information retrieval system;
- a monitoring system; and
- a warning system.

3.1 The Monitoring/Warning Feedback Loop

3.1.1 Introduction. In recent months, the ARPA/DIA Memorandum of Understanding has permitted Early Warning and Monitoring project staff to interact with DIA/NMIC personnel. This contact has provided us with new perspectives on our attempt to develop an interactive, computer-based system for early warning and monitoring. We are now much more aware of user needs and responsibilities.

In addition to needs of the I&W community, the Early Warning and Monitoring System also reflects, to a limited extent, the new emphasis the academic community has placed on the study of monitoring and warning processes in recent years.[1] The monitoring process has been conceptualized as involving four steps: data collection, screening, evaluation, and threshold setting.[2] To date, basic research has

[1] The best examples of this include Snyder, Hermann, and Lasswell (1976), the many thoughtful and suggestive comments provoked by their effort in subsequent issues of International Studies Quarterly, and the theme of the 1977 International Studies Association Convention. These excellent efforts are long overdue.

[2] These steps are described by Martino (1972):237-42.

focused primarily on data collection and screening, tending to neglect evaluation and thresholding. Given the importance of the first two steps, this is understandable. As those familiar with the history of the project are aware, the Early Warning and Monitoring System would not have been possible without more than a decade of data collection and screening. Without the efforts of dozens of individuals, we would not have the foundation of the system--the WEIS data and the methodology which accompanies it. Now, however, the conjunction of several factors--

- findings from years of basic research,
- advances in computer technology, and
- access to an operational environment--

not only permits but requires greater attention to the evaluation and thresholding components of the monitoring process and a conceptual connection between it and the warning process.

3.1.2 From monitoring to warning. The purpose of monitoring is to provide signals and patterns of signals for analysis. The objective of analysis, which in part involves attaching thresholds to patterns, is to warn of future events. The evaluation component of monitoring involves such things as searching for patterns in signals; separating signals from noise; interpreting, integrating and weighting signals; and relating identified patterns to context. In short, the process of evaluation consists of identifying possible warning patterns in signals and searching for additional signals which may strengthen or disconfirm the pattern. If a pattern is identified, a threshold is attached to it. If the pattern crosses the threshold, a warning is given.[3]

[3] Ibid.

Figure 3-1 illustrates the above description of the monitoring process. As a result of attempts to apply these concepts, we have learned that they are oversimplified. Since monitoring can be a process unto inself, with no intention to provide warnings, the linkages between and among the concepts must be clearly specified. As illustrated in Figure 3-2, monitoring and warning must be linked in a feedback loop. The setting of thresholds, and the hits, misses, false alarms by which they are evaluated, have a dual role. They must be considered at both the monitoring and warning stages of the whole process. The warnings given (or not given) by initial thresholds must be evaluated in terms of their hits, misses, and false alarms. The results of this evaluation must feed back to the monitoring component to improve indicator calculation, weighting, and integration; data collection and screening; and the thresholds themselves.

Not only must monitoring and warning be considered as separate but linked components of a single process and thresholds be given a dual role, but also less obvious considerations must be included in the process. As illustrated in Figure 3-2, the variable preferences and responsibilities of the decisionmaker must be taken into account. Thresholds must not be set solely by empirical considerations; they must reflect the costs of misses and false alarms as well as the relative utility of hits and correct rejections. User preferences and responsibilities must impact on the tasks of threshold setting and evaluation.

3.2 Scans

A scan is an aggregation of countries by some criteria, e.g., a scan defined by geographic location would aggregate countries into groups such as a Middle Eastern region. A general scanning capability improves the monitoring and

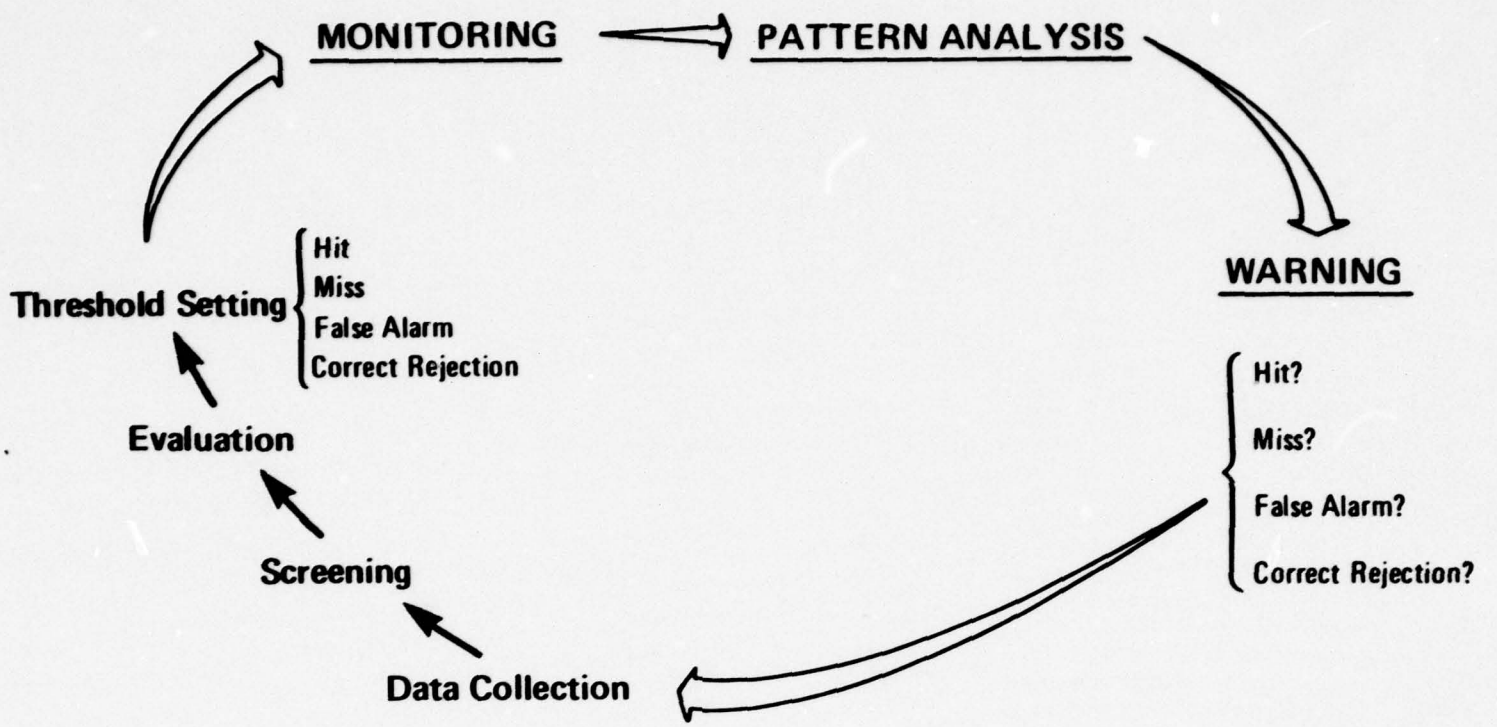

Figure 3-1

SKELETON OF THE MONITORING AND WARNING PROCESS

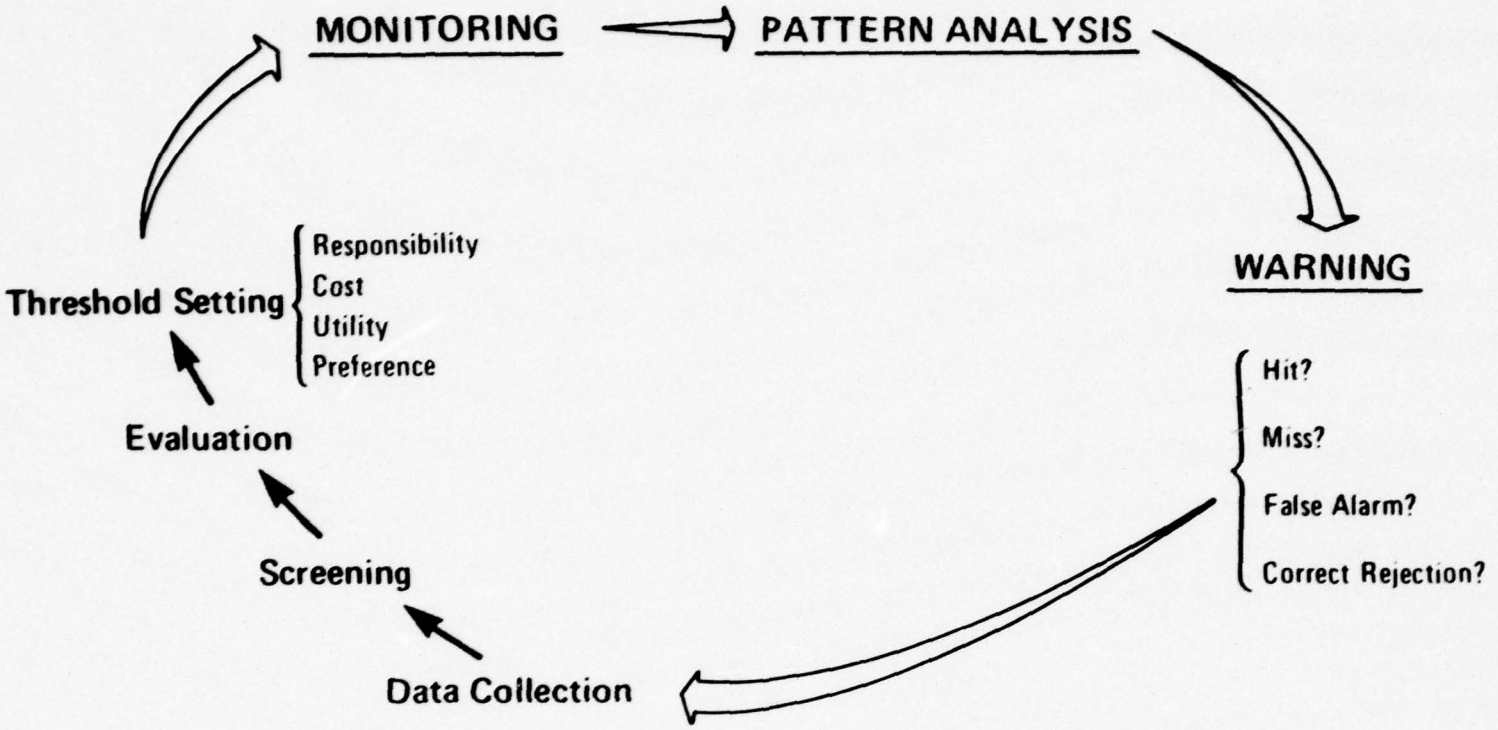

Figure 3-2

FEEDBACK LINKAGES OF THE MONITORING AND WARNING PROCESS

warning performance of the system in many ways. A general scan allows an analyst to look at several countries taken together rather than singly at many country pairs. If the indicators for the group as a whole suggest unusually high activity, tension, or uncertainty, the analyst can drop to the country-by-country level or even track the recent activity of a single country to determine the source of the disturbance on the regional level. General scans thus make the system much more efficient and less time-consuming for the analyst.

More specifically, general scans have four purposes: (1) to increase analyst efficiency and save him time; (2) to lengthen warning time before crisis; (3) to monitor and to provide a characterization of the relationship between country pairs and the world as a whole; and (4) to facilitate and enhance crisis management.

As illustrated in Figure 3-3, there are several possible types of general scans: (1) Joint Chiefs of Staff (JCS) regions--which are currently used in the early warning system; (2) other geographical regions; (3) systemic scans; (4) national interest scans; (5) attribute typology scans; and (6) foreign policy output scans.

The master version of EWAMS is now front-ended with JCS regions. This particular scan allows the analyst to track a JCS region as a whole, to look at any combination of countries within the region, any combination of countries within and without the region, any country with any region, and to create his own region. While potential users have reacted very favorably to JCS regional scans, other types of general scans are under development. Regional scans based on other than JCS considerations would contain more and more narrowly defined regions. For example, the JCS Middle East and North Africa region might be broken into two regions. Final

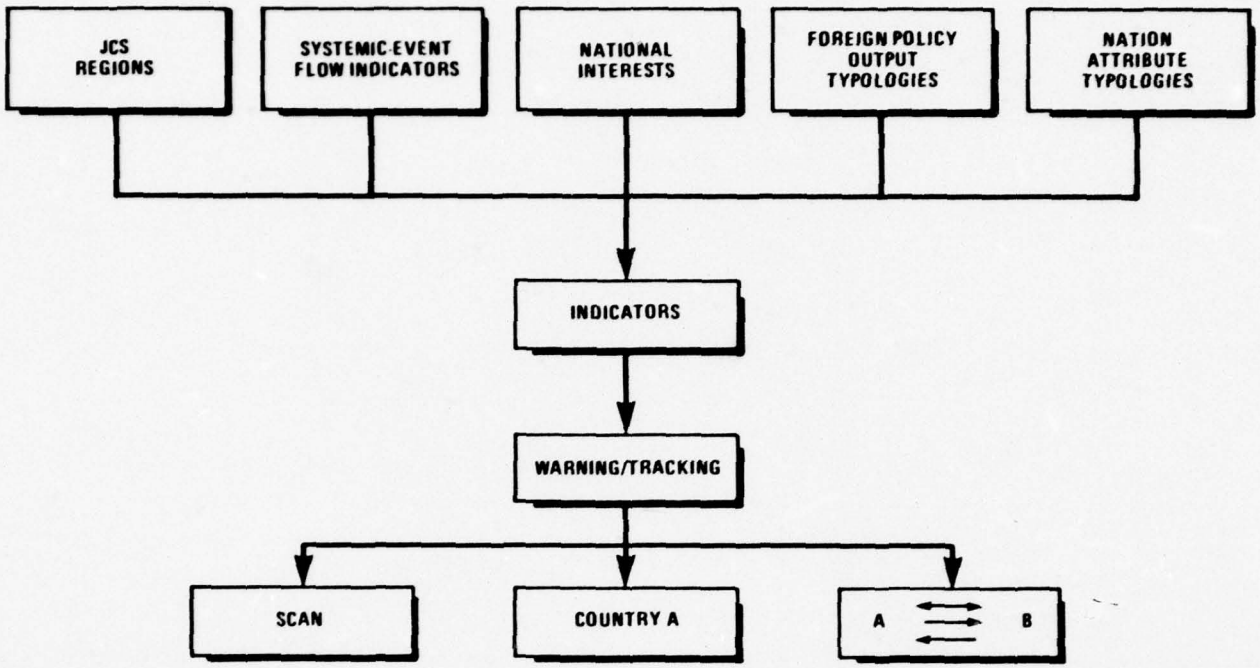

Figure 3-3
SCANS

incorporation of these into the early warning system will be determined by: (1) the results of our testing and evaluation; and (2) feedback from potential users.

Systemic scans would compliment a flexible regional scanning capability. There are several possible types of scans of the whole international system. One which will be integrated into the master version of the demo in the very near future is a variant of McClelland's Event Flow Indicators (EFI)[4] which has been successfully tested and demonstrated to yield weekly warning and tracking of threat conditions in the international political system. Another version of a systemic scan which is being tested and evaluated will yield a weekly alert list of the ten most likely crises, i.e., the ten country pairs with the highest crisis probability.

Scans using political indicators will be supplemented by other types of scans such as national interest ones. There are several possible varieties and combinations of national interest scans. For example, scans could be based on the political, economic, or military national interests of the U.S., its allies, or adversaries. An analyst could track just those countries with which the U.S. has a strong economic tie and interest. This capability requires further testing on the military commitments and arms transfers of the U.S., U.K., France, West Germany, China, and Japan (Martin 1977b). These quantitative indicators of military national interests are being evaluated for their effectiveness as a national interest scan.

Scans can also be based on categorization of nations according to their attributes (see, for example, Rossa 1977; East 1973; Wilkenfeld et al. 1978). For example, the analyst might want to track just large developing countries or communist countries. Finally, scans based on foreign policy output typologies should be explored (see Young 1975

[4] McClelland (1976).

and Kegley 1973). An analyst might track only diplomatically active or hostile countries.

By tracking a group of countries, whether defined by national interests or regions or the entire system, rather than tracking a large number of country pairs, the analyst makes more efficient use of his time. If the quantitative indicators reveal increased conflictual activity, tension, or uncertainty at the general scan level, the analyst can then focus on the country-by-country level, or even track a single country's actions to determine the source of the disturbance.

Some general scans should also lengthen lead time before crises. For example, changes in economic national interests are sometimes the source of political/military crises. An analyst tracking countries with which the U.S. (or its allies or adversaries) had a strong economic tie, might have a great deal of crisis warning. Other types of scans should also lengthen lead time. For example, greater warning of the 1973 Middle East War was provided by tracking U.S.-Soviet relations than by tracking the most immediate participants (Daly 1977). The several types of scans are, of course, being rigorously tested to determine their utility for early warning.

In addition to increasing analyst efficiency in monitoring and providing greater warning time, both of which could contribute to improved crisis management, general scans can make a direct contribution to improved performance by operations staffs. This could be accomplished by operations contingency planning for possible crises involving the countries covered by one or several types of general scans. Few international crises have only two participants (recent crises in Africa being cases in point). An African I&W analyst, using a geographic general scan, could work with

those tasked with developing contingency plans for managing African crises. The same would hold for warning and managing crises stemming from economic national interests. Coordination and communication between the I&W analyst and those tasked with management would provide the manager with greater warning time and supplement his expertise.

3.3 Quantitative Indicators for Early Warning and Monitoring

Along with the EWAMS computer base, the quantitative indicators are the foundation of the system design. Without on-going testing, evaluation and improvement of these indicators, the newer components in system design (both conceptual and actual) would be irrelevant to the I&W community.

3.3.1 Range and use of indicators. As illustrated in Figure 3-4, the range of indicators in the system design includes domestic and international political, military, and economic ones. The indicators are both dynamic (events-based) and static (attribute-based). The quantitative international political indicators are based on twelve years of historical data and on current, regularly up-dated data. It is hoped the military, economic, and some of the domestic indicators will also be based on real-time data in FY 78.

The quantitative political indicators currently in use are shown in Figure 3-5. Other indicators are currently being thoroughly tested and evaluated for incorporation into the system. (Details of these tests can be found in Section 4.2.) For example, attribute-based indicators can serve a dual function: In addition to their use in general scans (discussed in Section 3.2), attribute data can be used to measure and monitor relative capabilities of states (Rummel 1963, 1972; Daly 1976). A measure of relative capabilities would assist the I&W analyst in determining which potential crises have the most risk for the U.S. or

MILITARY				POLITICAL				ECONOMIC			
Static		Dynamic		Static		Dynamic		Static		Dynamic	
I	E	I	E	I	E	I	E	I	E	I	E

I – INTERNAL
E – EXTERNAL

Figure 3-4
RANGE OF CRISIS INDICATORS

	Volume	Variety
One Way Flow (A ⟶ B) (B ⟶ A)	Total Activity Level Cooperative Activity Level Conflictual Activity Level	Tension Level Uncertainty Level
Two Way Flow (A ⟷ B)	Total Activity Level Cooperative Activity Level Conflictual Activity Level	Tension Level Uncertainty Level

Figure 3-5
POLITICAL EVENT INDICATORS

its allies. To continue the old debate over the importance of intentions versus capabilities, more dynamic indicators than attribute-based ones can be used to measure and monitor intentions. Such indicators can be generated by either empirical or subjective means. Inclusion of both capability and intention indicators in the prototype would supplement the analyst's own expertise on the relationship between capabilities and intentions. Developments in capabilities can provide an empirical basis for assessing intentions. Furthermore, measures of intentions can also serve as a check on other quantitative crisis indicators.

Categorization and use of political, military, and economic indicators is not new in I&W. Political factors are viewed as (1) the context for military activity and (2) as the determinants of the decision to use military force. The design of the EWAMS system therefore views political indicators as useful for several reasons. First, with the possible exception of surprise attacks, political indicators will tend to lead military ones and will likely provide greater warning time before crises. Second, political indicators can substantiate or disconfirm interpretations based on military or economic ones. For example, increased military activity might be interpreted as an exercise. However, if political indicators are also registering increasing enmity between two countries, a warning of conflict might be given. This suggests a third function of political indicators--they may help distinguish between exercises and actual mobilizations as well as assist interpretation of the reasons for a given exercise, i.e., whether it is "normal" or being conducted for political purposes. As discussed above, setting thresholds for indicators is a crucial step in warning based on quantitative indicators. Therefore, a final use of political indicators for the EWAMS system design is to improve the performance of military indicator thresholds by comparing them with tested and

evaluated political indicator ones. In summary, the use of political indicators for I&W is not novel, it is merely their quantitative nature which is somewhat new.

Though used, economic indicators have received less attention in I&W. Analysts with long and diverse I&W experience have suggested that this lack of attention can be attributed to the few post World War II conflicts that would illustrate the type and scope of economic measures that a highly industrialized state might take in preparation for major hostilities. Another factor contributing to the present status of economic indicators is the difficulties involved in developing or obtaining valuable world-wide economic time-series data for small temporal aggregations. However, economic indicators have been included in system design on the assumption that they are a measure of national priorities, of resource allocation (or reallocation) for war or peace. To the extent this assumption is correct and indicators can be developed to measure changes in allocation of economic resources toward war, economic indicators will provide greater warning time of conflict than political ones and political indicators will in turn lead military ones.

Finally, military, economic, political, and domestic indicators can be used for information retrieval, monitoring, and warning. For example, indicators of the economic or military relations between two countries can be used to guide retrieval of historical information as well as to develop profiles for monitoring. The monitoring function in turn informs warnings generated by the indicators. For example, suppose an analyst warned his supervisor that troops were massing on the border of countries X and Y. The seriousness and potential implications of such military action would be difficult to evaluate independent of current information on the political and economic relations between the countries as well as information on past military actions

of a similar nature. The indicators are the core of each of the three separable but related EWAMS functions. As such, they serve as the link between its information retrieval, monitoring, and warning functions.

3.3.2 Generation of indicators. The methodology underlying the quantitative international political indicators has been thoroughly documented elsewhere (Andriole 1976a: 25-32). The University of Maryland's Cross-National Crisis Indicators Project is developing and testing intranational indicators for warning and monitoring. These will eventually be integrated into EWAMS and provide the system with the capacity to monitor and warn of domestic conflicts.[5]

Generation of military indicators is proceeding along two fronts. As any reader of a daily newspaper is aware, some data on dynamic military events is publicly available. Indeed, much of it appears in the WEIS political data set. However, this data is quite different from classified military indicators in terms of specificity, variety, and immediacy. Therefore, the primary thrust of the work on military indicators has not been to generate new ones, but to compare political indicators with extant military indicators. How this type of military indicator will be incorporated into system design is still uncertain. Depending on research results and bureaucratic politics, political and military indicator systems could be run in parallel or, alternatively, integrated into one system. (For elaboration on this work, see Section 4.2.) The second thrust of the work on military data has involved indicator development from public source data. In general, this attribute data is more static and, thus, more relevant to the scanning capability than to dynamic daily monitoring.

The current focus on economic indicator generation has been on dynamic indicators such as currency exchange

[5] See Wilkenfeld & Hopple (1977).

rates. This is in consonance with our present emphasis on current, "real-time" monitoring and warning. Data sources for such economic indicators include the U.S. Government's weekly economic indicators[6] and OECD data.[7]

3.3.3 Indicators of U.S. national interests. Those familiar with the history of EWAMS have by now noted that indicators of U.S. national interests have become less salient in system design. This is not because expectations of their substantive importance have been lowered. As suggested by the sections on scans and linkage of crisis warning and management functions, the conceptual role of national interest indicators has been expanded. If they seem to be less prominent in system design, it is because potential users of EWAMS require current data, and our research efforts must be devoted to indicators for which there is and will continue to be such data. While the excellent work done on the military commitment interests of the U.S., U.K., U.S.S.R., France, West Germany, Japan and China supports the dual role of national interests in system design, that effort has terminated (Martin 1977a, 1977b, 1976). Until updated and current data on U.S. national interests is available, it cannot be included among those components of system design to which most intensive research effort is devoted.

3.4 Computer Base

The ARPA/CTO Development and Demonstration Facility (DDF) provides the computer base for EWAMS. Current status of the DDF-based EWAMS hardware and software can be summarized as:

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[6] A publication entitled Economic Indicators Weekly Review, prepared by the U.S. Government and distributed on a subscription basis by the Document Expediting (DOCEX) Project, Library of Congress.

[7] This data has been provided through the cooperation of the U.S. Department of State and Mr. Robert Sarsfield.

- Hardware
  - PDP 11/70 minicomputer
    --128 K words with cache memory
    --88 million characters of off-line storage
    --9 track magnetic tape off-line storage
  - Tektronix 4051 graphic terminals
  - Tektronix 4631 hardcopy units
  - Tektronix 4097 floppy disc

- Software
  - UNIX operating system
  - CULC's FORTRAN IV Plus
  - Tektronix Plot 10
    --TCS (Terminal Control System)
    --AGII (Advanced Graphing II)
  - Binary and Random Access Data Files

Short-term enhancements planned for EWAMS hardware and software include:

- Hardware
  - Univac 1652
  - Joystick
  - Light Pen

- Software
  - Overlays
  - Calendar routines
  - Additional Graphics
  - Maps
  - Help Routines
  - Stat Pak Interfacing

To an extent, long-range design of the EWAMS computer base depends on the DDF design which is, of course, under separate purview. However, it is the goal of both EWAMS and DDF personnel to test and transfer a fully integrated, flexible interactive computer-based early warning and monitoring system.

3.5 Three Systems in One

Though retrospective application of the Early Warning and Monitoring System has illustrated many problems, it also demonstrates the great potential of the system. In light of

the myriad problems and issues still to be resolved, perhaps the greatest danger revealed by our interaction with potential users is retreat from the potential to something that is merely an information retrieval system. Thus a broad comprehensive problem is:

- Information retrieval vs. warning and monitoring
  - How can devolution from a warning and/or monitoring system to an information retrieval system be avoided?

An information retrieval system would be "safe": many of the critical problems associated with it have already been solved. An information retrieval system alone would benefit I&W analysts. However, the requirements of real-world I&W suggest we cannot afford to "play it safe"; we cannot scale down our objectives in the face of diverse and difficult problems.

A more positive statement of the devolution problem would be:

> How can a monitoring system successfully make the transition to a warning system?

The answer, of course, requires solutions to many problems and issues. And the solutions must reflect extensive and detailed input from the user community. Such input will not only help us make the transition from monitoring to warning; by showing the potential of the system to real-world analysts, it will hopefully convince users that something more than an information retrieval system would be of use to them.

One way of doing this is to offer three systems in one. Analysts could then use one or all system functions of information retrieval, monitoring, or warning. Use would be determined in part by analyst responsibilities and preferences.

As illustrated in Figure 3-6, EWAMS has information retrieval, monitoring, and warning capabilities. Information retrieval is represented by the ability to obtain the

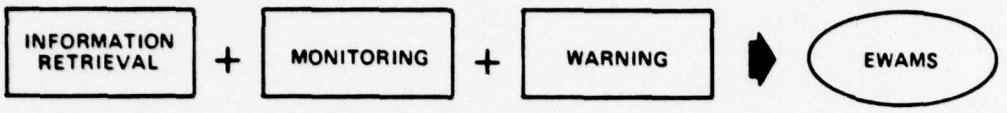


Figure 3-6
THREE SYSTEMS IN ONE

textual information from which the quantitative indicators are generated, as well as tables and graphs of these indicators. Monitoring consists of EWAMS capability to describe relationships among countries and regions (both with the world) on a current, daily basis in terms of several quantitative political indicators or narrative information. The latter provides context to the analyst, enabling him to more readily interpret the signals of the quantitative indicators. Warning capability currently consists of an associative generation of conflict probabilities. Pattern analysis provided by retrospective monitoring is the foundation of these warning probabilities.

Modifications and enhancements to each of these systems have been designed. Eventually, economic, military, and domestic information of both the events and attribute types will be retrievable. Monitoring capability will likewise be expanded in terms of substance that can be described and patterns that can be analyzed. The plans for enhancement of warning capabilities are the most ambitious enhancement. Military, economic, and domestic indicators for warning are

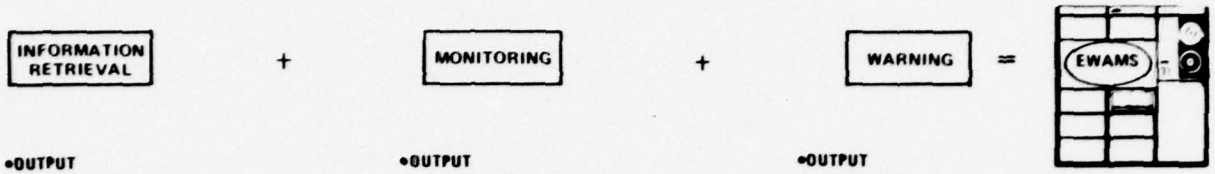
being developed and tested in preparation for integration into EWAMS. The method for associative generation of probabilities is being tested and refined and thresholds for the indicators are being developed. In addition, different forecasting methods are being developed by other Crisis Management Program contractors. (Werbos 1977; Duncan and Job 1977) If testing and evaluation are successful, these forecasting methods will be integrated into EWAMS.

These modifications and enhancements to the design of the information retrieval, monitoring, and warning capabilities of EWAMS will enhance the utility of the system to those in the I&W community. The design and development of three systems in one, rather than incremental phased development and introduction, is intended to demonstrate the potential of an interactive computer-based warning system.

3.6 Conceptual Design of an Integrated Early Warning and Monitoring System

In the preceding discussion, mention has been made of both current status and future design of EWAMS. Figures 3-7 and 3-8 illustrate, respectively, the primary outputs and functions of the present system and its planned development. A comparison of the figures suggests four topics that will need to be addressed as the design is implemented: integration/amalgamation of indicators, transitioning from monitoring to warning, exploring linkages between warning and management functions, and "intelligent" I&W.

3.6.1 Integration/amalgamation of indicators. Problems with indicator integration occur on two levels. The first concerns integrating, interpreting, and weighting the varying signals of different indicators of one generic type, e.g., five international political indicators. Ongoing research suggests this is a difficult but solvable problem.



•OUTPUT

- DESCRIPTIVE
- TEXT & DATA
- HISTORICAL PATTERNS FOR 5 INTERNATIONAL POLITICAL INDICATORS, 1966-PRESENT
- TABLES & GRAPHS

•FUNCTIONS

- INFORMATION STORAGE AND RETRIEVAL
- AID TO MEMORY
- HISTORICAL CONTEXT
- PATTERN ANALYSIS OF PAST

•OUTPUT

- DESCRIPTIVE
- CURRENT, DAILY PERFORMANCE OF 5 INTERNATIONAL POLITICAL INDICATORS
- 22 EVENT TYPES, TEXT, DATA
- REGIONS, COUNTRIES, WORLD

•FUNCTIONS

- TRACK DAILY INTERACTIONS ANY COUNTRIES, REGIONS
- COMPARE TO OTHER MONITORING SYSTEMS
- SUPPLEMENT OUTPUT MILITARY MONITORING SYSTEMS
- TEXT PROVIDES CONTEXT TO INTERPRET INDICATOR ACTIVITY

•OUTPUT

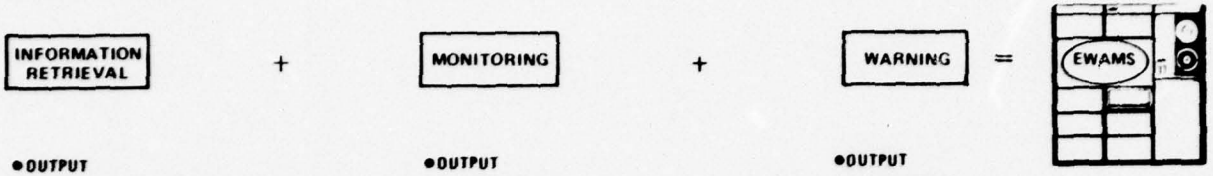
- PREDICTIVE
- ASSOCIATIONAL
- PROBABILITIES OF CONFLICT
- DEVIATIONS FROM NORMAL
- REGIONS, COUNTRIES, WORLD

•FUNCTIONS

- WARNING
- CONFIRM/DISCONFIRM INDICATIONS FROM OTHER SOURCES
- SUGGEST TRACK/NOT TRACK MILITARY INDICATORS
- EVALUATION AND THRESHOLDING INDICATORS, PROBABILITIES, FOUNDATION OF WARNING
- HIT, MISS, FALSE ALARM RATES FEED BACK TO IMPROVE WARNING PERFORMANCE

Figure 3-7

CURRENT STATUS OF EARLY WARNING & MONITORING SYSTEM



●OUTPUT

- CURRENT +
- HISTORICAL DATA AND PATTERNS FOR MILITARY, ECONOMIC, DOMESTIC, AND U.S. MILITARY COMMITMENT INDICATORS
- TABLES AND GRAPHS

●FUNCTIONS

- CURRENT +
- ANALYSIS PATTERNS IN PAST MILITARY, ECONOMIC, DOMESTIC & U.S. MILITARY COMMITMENT FOUNDATION OF MONITORING

●OUTPUT

- CURRENT +
- SCANS (regions, systemic, output, and attribute type)
- CURRENT PERFORMANCE MILITARY ECONOMIC, DOMESTIC, NATIONAL INTEREST INDICATOR
- SINGLE COUNTRY POLITICAL, MILITARY, ECONOMIC INDICATORS

●FUNCTIONS

- CURRENT +
- SCANS – INCREASE ANALYST EFFICIENCY
- TOP DOWN (systemic scan, country pair single country) – INCREASE ANALYST EFFICIENCY
- COMPARE TRACKING, SIGNALS DIFFERENT TYPES OF INDICATORS
- FOUNDATION OF OPS/INTELLIGENCE LINK?

●OUTPUT

- CURRENT +
- CONFLICT WARNING BASED ON
  - scans
  - domestic, military, economic single country indicators
- ANALYST DETERMINED THRESHOLDS AND TAILS
- REGRESSION, MARKOV BASED, AND DECISION ANALYTIC FORECASTING METHODS

●FUNCTIONS

- CURRENT +
- TOP DOWN WARNING
- COMPARE, CROSS CHECK WARNINGS DIFFERENT TYPES OF INDICATORS
- HIT, MISS, FALSE ALARM RATES FEED BACK TO IMPROVE INDICATOR PERFORMANCE
- MULTI TRACK, MULTI METHOD WARNING CAPABILITY
- INTELLIGENT I&W

Figure 3-8

DESIGN FOR INTEGRATED EARLY WARNING & MONITORING SYSTEM

As illustrated by Figure 3-8, problems of indicator integration are present on another level. Substantively different indicators must be pulled together in a single system. The problem is compounded by the fact that EWAMS is in a relatively advanced stage of development as a political indicator system and that DIA/NMIC's military indicator system is at about the same stage. Integrating these two systems would be a massive task in terms of concept, methodology, classification, hardware, and software. Therefore, for the short term, it is likely there will be three separate indicator systems--political, military, and economic. Economic indicators will be developed and tested outside the master version of EWAMS; the same procedure will be followed with military indicators based on open source data and domestic indicators. However, as these economic, military, and domestic indicator systems approach the EWAMS level of development, they will be integrated into its master version.

For the immediate future, the military and political prototype warning systems will be run in parallel. However, the possibility of potential integration will always be kept in mind and used to evaluate any major changes in EWAMS design.

3.6.2 From monitoring to warning. There are two major components to the problem of making the transition from monitoring to warning. The first is methodological and involves setting indicator thresholds and generating probabilities that produce hit, miss, and false alarm rates that are both acceptable to the user community and empirically valid. Resolution of this problem will facilitate solution of the second--persuading the I&W community to use all three EWAMS systems rather than just the information retrieval and monitoring ones.

It is anticipated that as economic, military, and domestic indicators are integrated into EWAMS, they will initially be used for monitoring and information retrieval. However, expansion of system capabilities to include warning should be very attractive to the analyst. He will be able to access information and indicators of several types, compare their signals, and use them to interpret signals from his other data sources. Given the time-sharing facilities of DDF, the analyst will be able to do this even before economic, military, and domestic indicators are integrated into EWAMS. He will be able to access them while they are in the stage of independent development and testing. The availability of these other indicators will hopefully add impetus to analyst use of the warning components of EWAMS.

There are two components of EWAMS design that are much farther downstream than indicator integration and transitioning from monitoring to warning. These are (1) linking warning and operations functions; and (2) developing a concept called "intelligent I&W." Both these topics are discussed in Section 7.0.

4.0 PROGRESS ON THE DEVELOPMENT AND TESTING OF AN EARLY WARNING AND MONITORING PROTOTYPE SYSTEM

Both current and potential development work has been discussed in Section 3.0. Therefore, this chapter will emphasize testing methods and results.

4.1 Development of the Early Warning and Monitoring Prototype System

4.1.1 Current status. The current status of the development of EWAMS is depicted in Figure 3-7 and summarized in Figure 4-1. Briefly, the system is comprised of

Figure 4-1
EARLY WARNING & MONITORING SYSTEM COMPONENTS

a JCS regional scan, five quantitative international political indicators, a short-range forecasting method, and an interactive computer base. As depicted in Figure 3-6, the indicators measure the volume and variety of interactions between or among nations. EWAMS also calculates z-scores, deviations from normal or baseline behavior, for each indicator.[1] Crisis probabilities are generated from these

[1]These deviations are similar in concept to the "unusualness" measure of some military indicator systems.

deviations (Daly and Bell 1977b). Output from the current version of EWAMS can be found in Appendix A, and system operation is explained in the User's Manual (Davies, 1978a).

4.1.2 Immediate enhancements. EWAMS is changing rapidly--so rapidly that some of the enhancements listed below may be completed by the time this report is distributed:

- addition of the Event Frequency Indicators (EFI) and Row Percentages and Column Z-Scores (ROZ) indicators--which in turn will require a new front end for the demo;
- plot probabilities and provide additional multi-plots;
- daily and weekly data which will entail development of new indicators;
- autoscan for the superpowers;
- monthly, weekly, daily alert lists.

4.2 Testing of the Early Warning and Monitoring Prototype System

The test results reported below are all based on retrospective analysis. As is often pointed out by those with long I&W experience and traditional training--similar, if not identical, types of problems do recur in crisis situations so that there is much to be learned from retrospective analysis. Examination of historical indicator performance is crucial in the attempt to develop, test, and threshold quantitative indicators so that they may be used for warning. However, if EWAMS is to be used in an operational setting, testing and evaluation with current daily data--real-time monitoring--are critical. Current daily updating of the EWAMS data has just recently begun. The capability to do real-time daily testing and monitoring will result in extensive modification of some indicators and development of new ones; it will expand the number and kinds of input and output options; most important, it will make EWAMS more

similar to extant military indicator systems. This will facilitate comparative testing of political and military indicators and acceptance of the system by potential users.[2]

4.2.1 Quantitative indicators. Testing of quantitative indicators has focused on ROZ, an indicator of single country activity; on cooperative and conflictual activity; on comparison of political indicators with extant military ones; and on the tension measure. All these indicators can be used for both monitoring and warning. However, for the indicators to be used for warning, either thresholds must be set or probabilities of crisis generated from them. Warning probabilities have been generated for indicators of total, cooperative, and conflictual activity. These are discussed in Section 4.2.2. Work is continuing on setting thresholds for the tension indicator, and it is likely that it will be the next EWAMS indicator to perform a genuine warning function. The tension measure and thresholds are discussed at the end of this section.

ROZ: Its Multiple Uses[3]

ROZ (row percentages and column z-scores) is "an indicator for single country performance that takes into account the country's weekly portion of the total (world) action and the extent to which that portion is exceptional in comparison to the ten-year average" (McClelland 1976). McClelland has demonstrated the effectiveness of ROZ as a warning sign of impending danger, a monitor of on-going trouble, and as an indicator of post-crisis shock. As such, ROZ contributes to all three EWAMS functions--information retrieval, monitoring, and warning. It has been used to

[2]Results of daily real-time monitoring and testing will be reported in forthcoming research memoranda.

[3]This section relies heavily on Daly and Wittmeyer (1977).

help determine what countries should be added to a sample for developing indicators of domestic conflict and linkages between intranational and international conflict linkages (Daly and Hopple 1977). And it has served as an experiment to aid in determining the standalone capabilities of a Tektronix 4051 graphics terminal.

The following description of testing and evaluation of the ROZ indicator is a report on both substance and technology. It builds (as always) on McClelland to present some interesting findings about ROZ performance between January 1976 and March 1977. In this sense it is the first step in one of our future tasks, i.e., to incorporate EFI, ROZ, and dyadic scans into EWAMS. Since ROZ's for 183 countries were generated with a standalone 4051 without a host computer, the section is also a report on computer technology.[4]

Modified ROZ: A combination of circumstances forced us to slightly modify McClelland's ROZ calculations. To obtain ROZ, he multiplies a country's percent of the global activity for a given period by its z-score for the period and adds a constant, or

$$ROZ = (Co\ \% \times Co\ z) + 30.$$

To calculate monthly ROZ's for 183 countries between January 1976 and March 1977, we: 1) substituted percentages for frequencies in calculation of the standard deviation; and 2) replaced a mean calculated on the frequency with McClelland's ten-year average percent (McClelland 1976) in the country z-score calculations.[5]

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[4]For documentation of the program see Daly and Wittmeyer (1977).

[5]Our calculations are as follows:

Since the primary purpose of a workable ROZ was to develop a list of countries which were current and potential sources of world trouble, tension, and threat rather than a list of those who exhibited this characteristic in the decade preceding 1976, it made sense to use McClelland's percent for 1966-75 as the mean. This modified ROZ would not only give us a reading on current and potential sources of trouble, but would also emphasize slightly the change in a country's recent performance as compared to its output in the 1966-75 decade.[6]

Although our function is less to do retrospective analyses of historical event flows and their crises than to monitor current ones and to provide early warning of the crises embedded in them, knowledge gained from the former is essential for the latter. The top forty-one nations, in terms of the average monthly percent of world activity initiated between January 1976 and March 1977, are presented in Table 4-1. The table also gives the rankings of the same countries for 1966-1975 according to McClelland's ten-year percent (McClelland 1976). Twenty-eight (68%) of the forty-one countries in the two lists are the same.[7]

$$z = \frac{(Co\% \times Co\ z) + 30 - x_i - x}{s}$$

where,
x_i = country's monthly %
x^i = country's 10-year % as in McClelland (1976)
s = standard deviation using % rather than frequency

[6]This method, initially developed as a one-time analysis to assist our judgment in increasing a sample, worked so well that it might be used as a substitute for McClelland's calculations when the analyst lacks access to a mainframe or the finances necessary to process the very large tables initially required for McClelland's ROZ calculations. We are in the process of comparing the modified ROZ with the original. Until then, however, a few interesting points derived from a modified ROZ are presented below.

[7]The contribution the 15-month rankings made to increasing a sample for developing and testing indicators of domestic conflict and of intra-international conflict linkages can be found in Daly and Hopple (1977).

Rankings	Average Z	McClelland Rank by Percent 1966-1975
1) USA	19.03	1(19.2)
2) USR	5.95	2(6.9)
3) PLO	4.32	14(1.5)
4) UNO	4.13	6(4.0)
5) LEB	4.04	24(.7)
6) ISR	3.86	4(5.7)
7) UNK	3.54	9(2.5)
8) RHO	3.38	>56(.2)
9) SYR	3.37	18(1.3)
10) UAR	3.15	7(3.8)
11) FRN	2.68	10(2.1)
12) ZIM	2.51	>56(.2)
13) SAF	1.82	>47<57(.3)
14) ANG	1.78	>56(.2)
15) GMW	1.56	11(2.1)
16) UGA	1.48	>47<57(.3)
17) ARL	1.37	>56(.2)
18) CHN	1.21	8(2.8)
19) JAP	1.13	17(1.4)
20) CUB	1.11	33(.5)
21) SAU	1.06	30(.6)
22) LBY	1.03	39(.5)
23) VTN	.89	3(6.7)
24) YUG	.88	28(.6)
25) ZAM	.87	>47<57(.3)
26) TUR	.76	29(.6)
27) POR	.74	>41<48(.4)
28) IRN	.70	38(.5)
29) CAN	.66	20(.9)
30) TAZ	.65	>57(.2)
31) JOR	.65	16(1.4)
32) IND	.65	15(1.4)
33) NIG	.63	>41<48(.4)
34) PHI	.60	>41<48(.4)
35) EEC	.59	26(.6)
36) GRC	.57	36(.5)
37) TAI	.56	31(.5)
38) COP	.52	>56(.2)
39) SPN	.52	>47<57(.3)
40) ALG	.47	>41<48(.4)
41) ITA	.46	34(.5)

Table 4-1

NATION ACTIVITY LEVELS
TOP 41 (⩾.45)
JAN 76 – MAR 77

Country	Rank(1/66-12/75)	Rank(1/76-3/77)
VTS	5	67
CAM	12	70
VCG	13	>151
PAK	19	58
GME	21	47
KOS	23	44
VAT	25	51
CZE	27	62
IRQ	32	54
KON	35	46
AUL	37	78
RUM	40	55
POL	41	90

Table 4-2

CHANGES IN NATION ACTIVITY LEVELS

In general, the differences between the 1966-75 and the January 1976-March 1977 lists are dramatic and fairly easy to explain. The PLO jumped from 14th for ten years to 3rd for the more recent fifteen months, reflecting its heightened recognition and its activity in Lebanon, the Middle East, and the world. Lebanon is also higher on the more current list, a reflection of its domestic strife and the international activity associated with the turmoil. It is likely the move of Syria from 18th to 9th is also a product of the Lebanese situation and Syria's involvement in it.

Explanation of departures from the decade's top forty-one would seem to be a mixture of U.S. disengagement in South East Asia and a greater acceptance of the status quo by Eastern Europe--or less active resistance to it. The thirteen entities high in activity from 1966-75 which disappeared from the more recent list (perhaps to reappear when ROZ is updated from April 1977 to the present) are listed in Table 4-2. Of these thirteen actors, the Koreas are the most likely to rejoin the top 41 in the immediate future.

As shown in Table 4-1, Asia and Eastern Europe have been replaced by Africa on the top forty-one. At least since January 1976, newcomers to the list are RHO, ZIM, SAF, ANG, UGA, ARL, ZAM, POR, TAZ, NIG, PHI, COP, SPN, and ALG. "It is conceivable that a basic system 'reorganization' took place" in 1974 (McClelland 1976:49). A rough comparison of ten years of ROZ with the subsequent fifteen months is not sufficient to confirm this. It does reveal, however, that the source of the world event flow changed substantially sometime prior to 1976. Further cross-period comparisons of ROZ should increase our understanding of any past and ongoing system transformations as well as enhance our early warning capability. The above demonstrates that cross-period comparisons of ROZ can improve our monitoring activities by redirecting our focus.

For all countries except the U.S., the ROZ danger threshold is 50; the redline for the U.S. is 70 (McClelland 1976:18). As illustrated by Table 4-3 and Figure 4-2, the U.S. ROZ broke 70 twice between January 1976 and March 1977. In April 1976 the U.S. initiated or responded to activity in such diverse locations as Somalia, Lebanon, and Rhodesia. The high ROZ might also be registering some aftershock of Angola which crossed the danger line in February and approached it in January (Figure 4-3). Although it did not break the redline of 50, the USSR ROZ for April 1976 was its second highest in the period (Figure 4-4). Like the U.S., it is likely this is a reflection of Soviet interest in Somalia, Lebanon, and Angola. The high U.S. ROZ for February 1977 precedes the Soviet crossover to the danger zone by one month. It is probable the former is in part tracking the Carter administration's initiatives on such issues as human rights and SALT with the latter reflecting Soviet responses.[8]

The PLO broke 50 in June and July 1976 and came fairly close in January (Figure 4-5). The "almost" coincides with the third highest Lebanese ROZ, while the June high adumbrates (as does that for Syria) the July and August danger levels for Lebanon (Figures 4-6 and 4-7). ROZ thus successfully monitored the activity of the three major international participants in the Lebanese conflict, and the June PLO and Syrian danger level readings could be interpreted as an early warning of the subsequent high ROZ for Lebanon.

The ROZ's of five African actors crossed into the danger zone during the fifteen months. In addition to Angola, mentioned above, Uganda, South Africa, Zimbabwe, and

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[8]For elaboration and confirmation of this point, see the output for USR-USA in Appendix A.

UNITED STATES ROZ JAN76-MAR77

OBSERVATION	FREQUENCY	PERCENT	Z-SCORE	ROZ
7601	98	14.040	-0.886	17.555
7602	60	13.667	-0.950	17.010
7603	95	20.386	0.204	34.154
7604	126	27.938	1.501	71.935
7605	117	19.055	-0.025	29.527
7606	212	22.458	0.560	42.567
7607	76	11.310	-1.355	14.671
7608	121	21.416	0.381	38.152
7609	115	24.573	0.923	52.679
7610	45	12.262	-1.192	15.385
7611	70	16.908	-0.394	23.343
7612	34	10.119	-1.560	14.215
7701	73	17.217	-0.341	24.135
7702	146	28.460	1.591	75.272
7703	139	25.646	1.107	58.397

AVG %	19.030
AVG ROZ	35.267
SUM %	285.454
MCQ #	19.200

Table 4-3

UNITED STATES
MONTHLY ROZ SCORES
JANUARY, 1976–MARCH, 1977

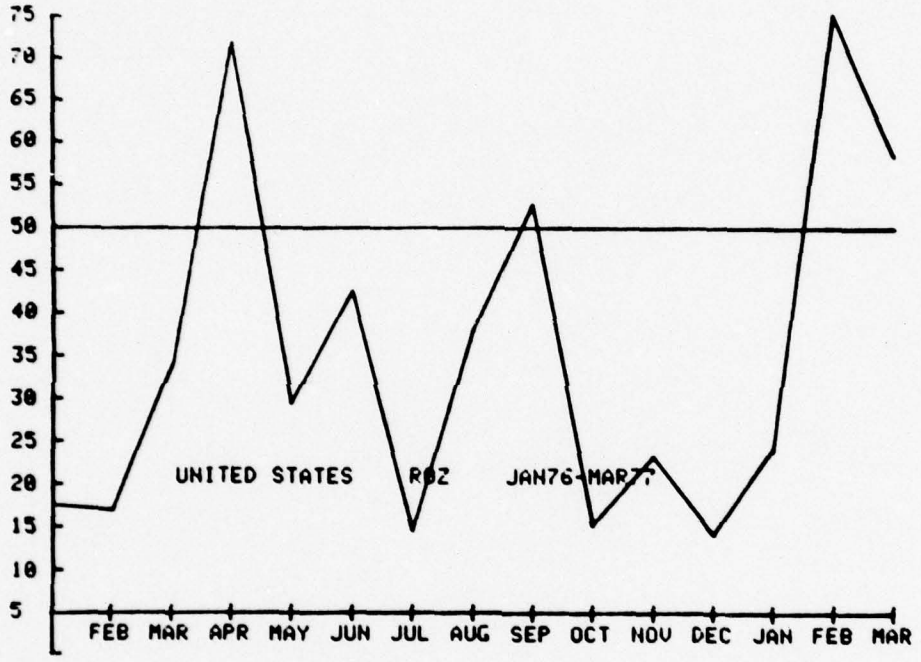


Figure 4-2
ROZ: UNITED STATES, 1976–1977

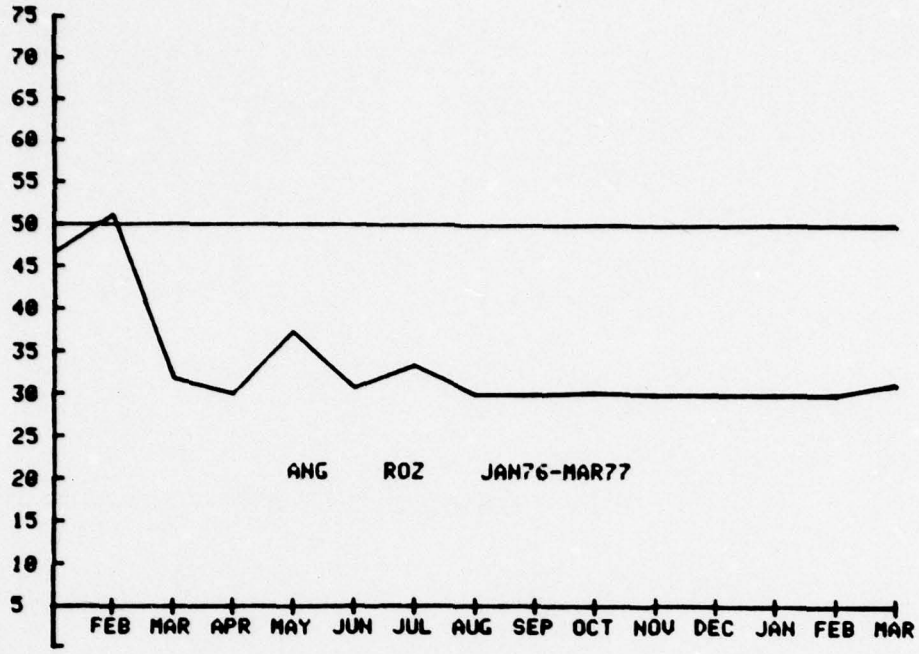


Figure 4-3
ROZ: ANGOLA, 1976–1977

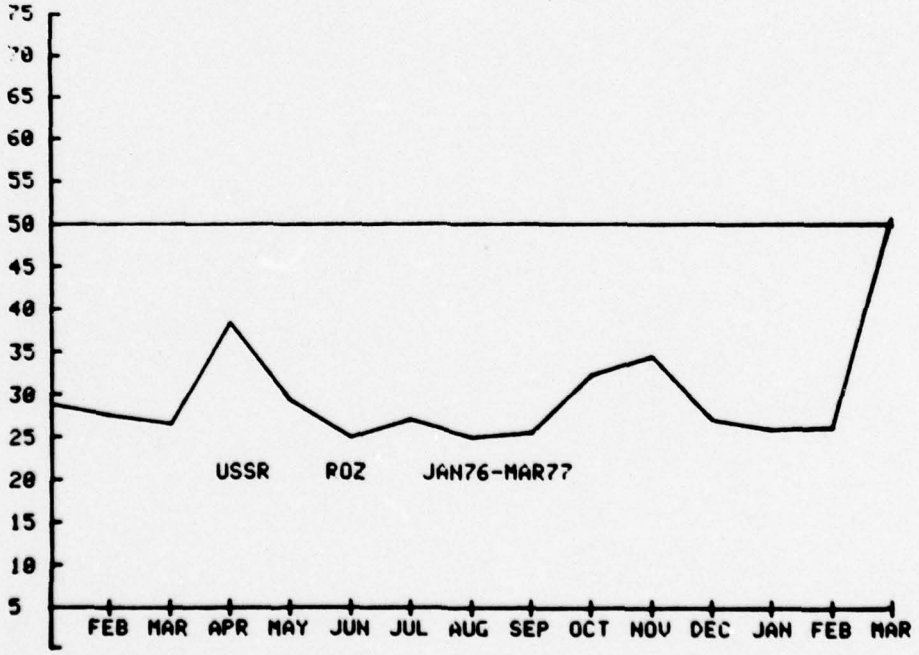


Figure 4-4
ROZ: SOVIET UNION, 1976–1977

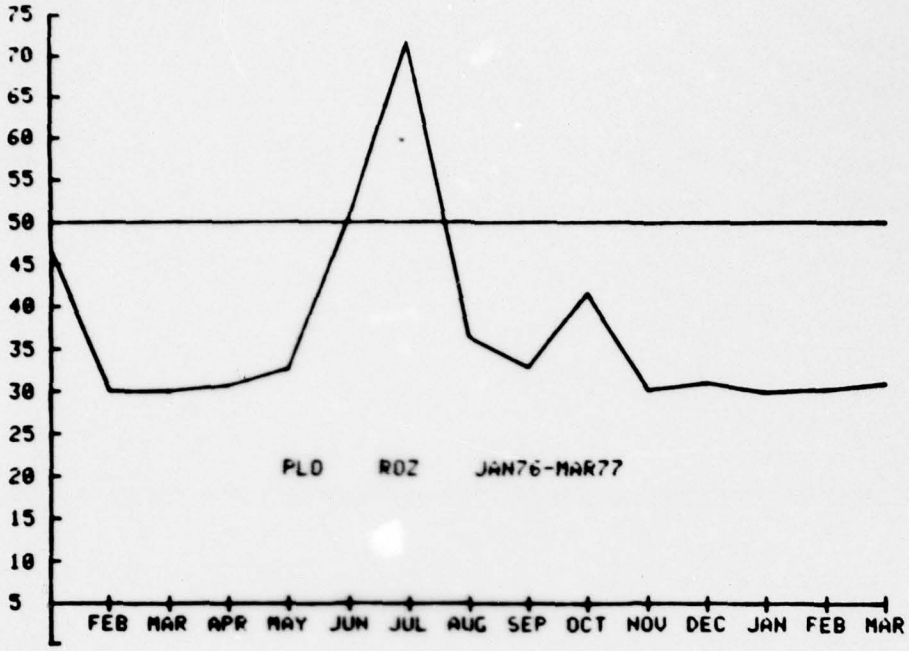


Figure 4-5
ROZ: PALESTINE LIBERATION ORGANIZATION, 1976–1977

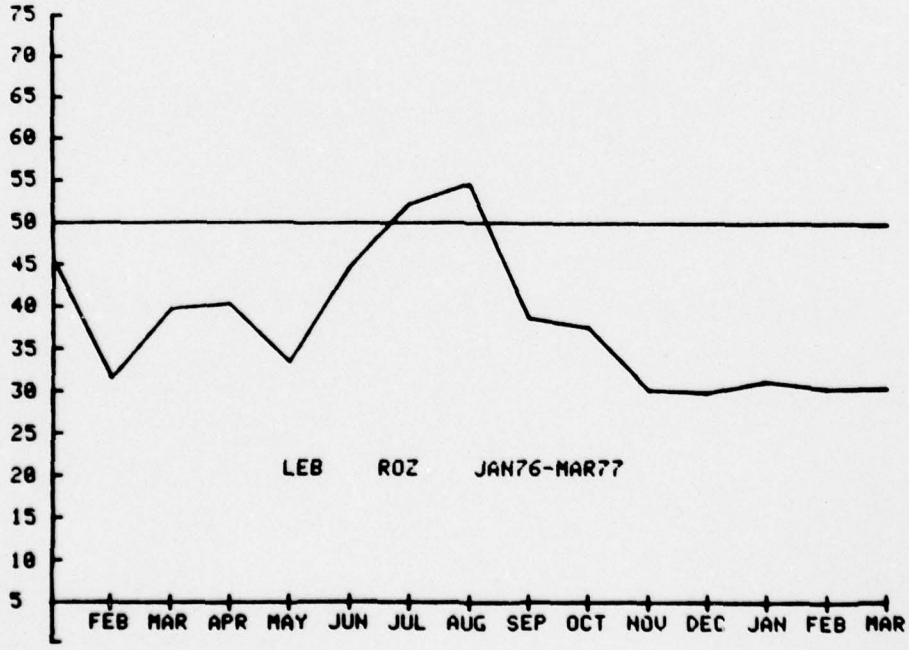


Figure 4-6
ROZ: LEBANON, 1976–1977

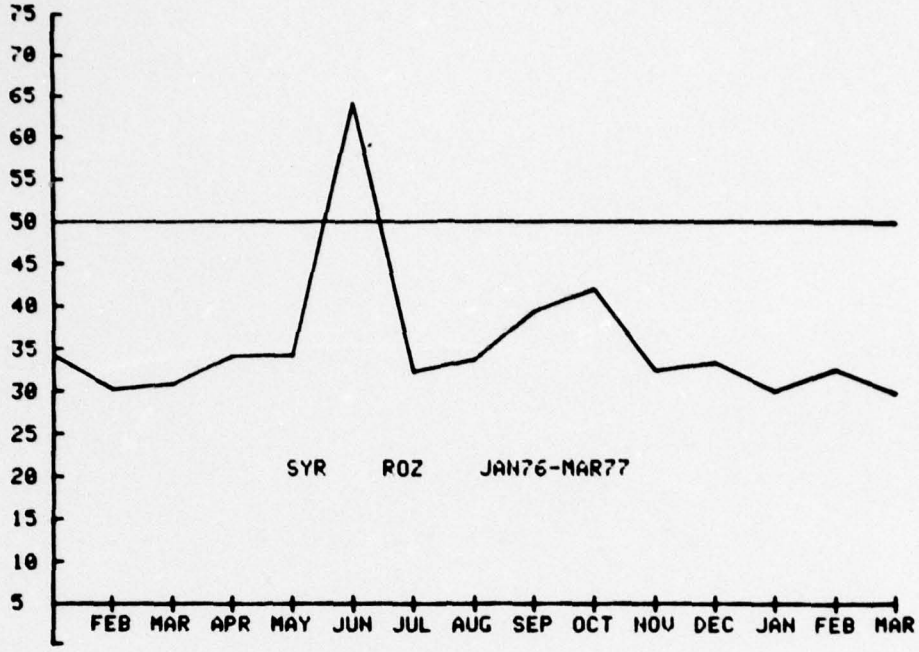


Figure 4-7
ROZ: SYRIA, 1976–1977

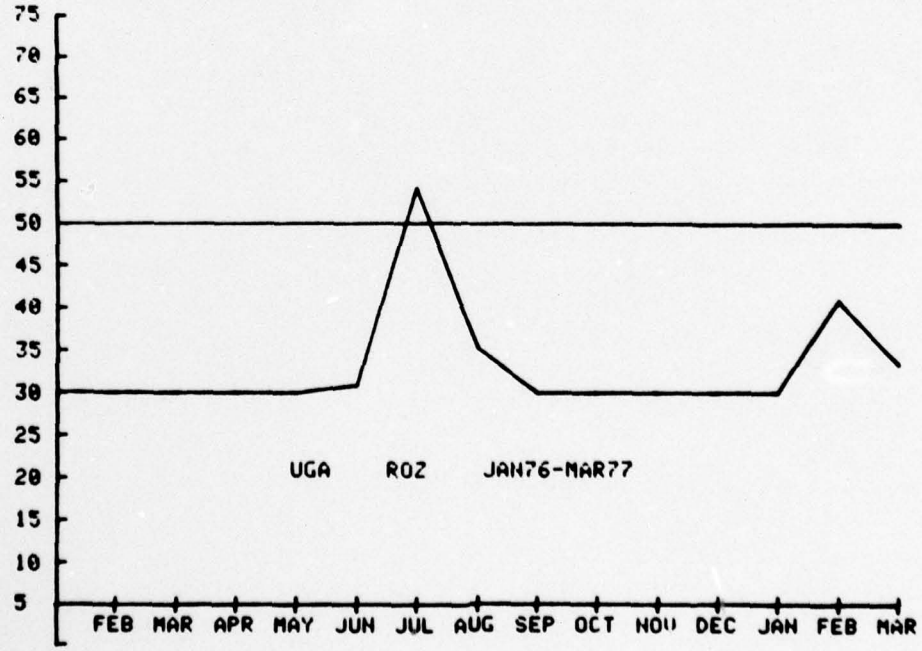


Figure 4-8
ROZ: UGANDA, 1976–1977

Rhodesia broke 50. Uganda's July 1976 ROZ is a retrospective recording of the Entebbe incident (Figure 4-8). South Africa's high ROZ in September is associated with riots and turmoil in Soweto and with pressure by South Africa on Rhodesia (Figure 4-9). The latter's highs in March, December, and an almost high in November, recorded the on-going conflict with Zimbabwe and the Geneva negotiations over the future of the country (Figure 4-10). Zimbabwe crossed the danger line in October and approached it in November (Figure 4-11). Illustrating that cross-continental ties still exist, the January 1977 ROZ of 1976 for UNK may partly reflect Britain's role in the Rhodesian negotiations (Figure 4-12).

ROZ seems to have successfully monitored and pinpointed the sources of most of the world's major dangers in the fifteen months between January 1976 and March 1977. To anticipate, possible monitoring failures might be the early phases of Angola, the Ethiopia-Eritrean conflict, and the North Korean killing of Americans in August. ROZ does seem to have provided some warning of increased conflict in Lebanon and of the heightened political tension between the U.S. and Soviets in the first quarter of 1977.

Future Development of ROZ: The most recent example of the immediate future of ROZ is McClelland's "TOL Monitor and Forecast" of 26 July 1977.[9] We intend to integrate New York Times (NYT)-based EFI and ROZ into EWAMS. As McClelland is doing with TOL (Times of London), the prototype will use EFI, or a variant of it, to track global event flows. When EFI moves into the danger range, ROZ's will be activated to reveal the source(s) of the EFI warnings. The final and/or parallel step in assisting the analysts' expertise is the use of dyadic volume and variety indicators already

[9]This is information taken from personal communication.

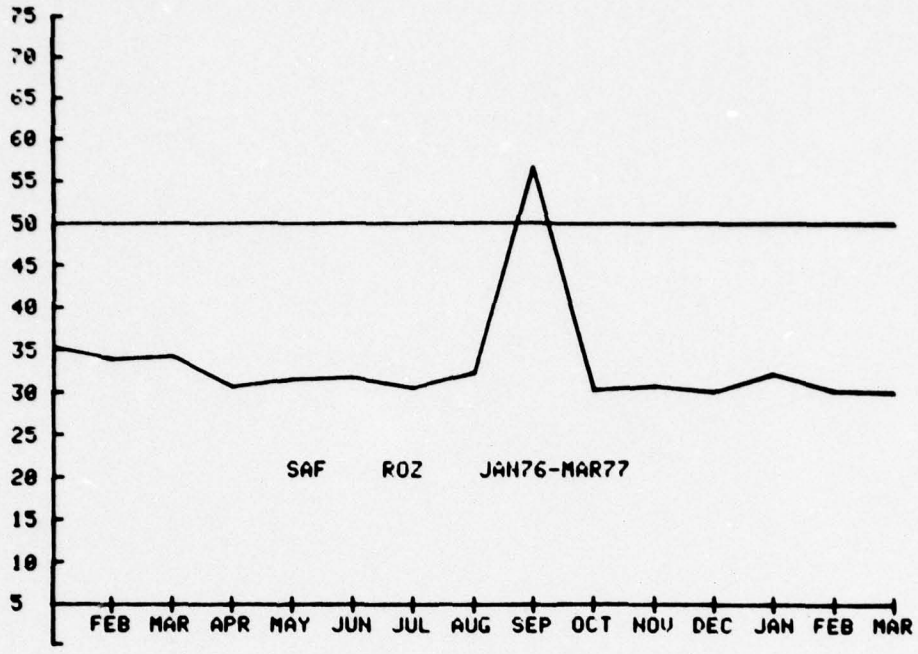


Figure 4-9
ROZ: SOUTH AFRICA, 1976–1977

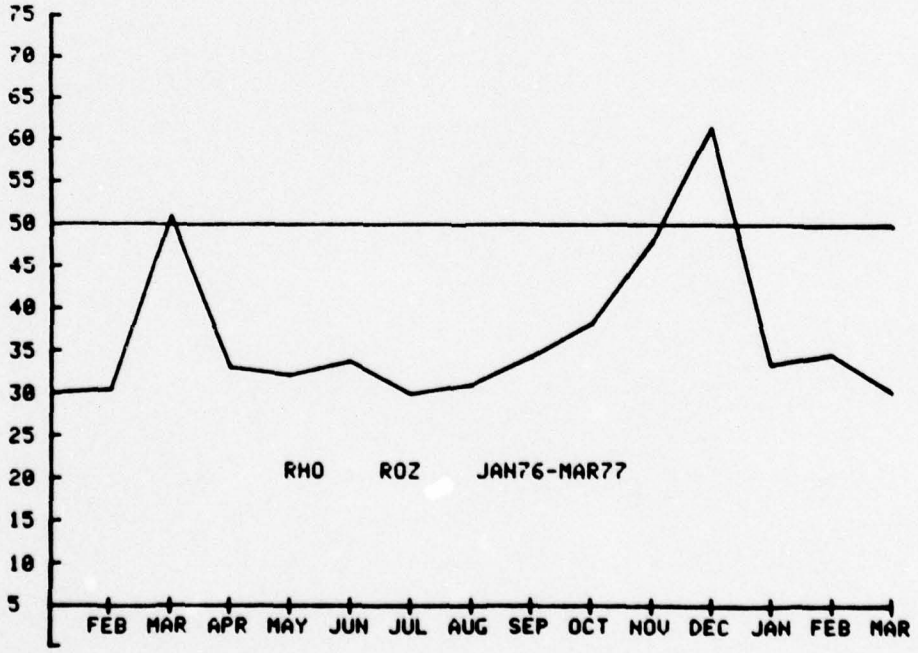


Figure 4-10
ROZ: RHODESIA, 1976–1977

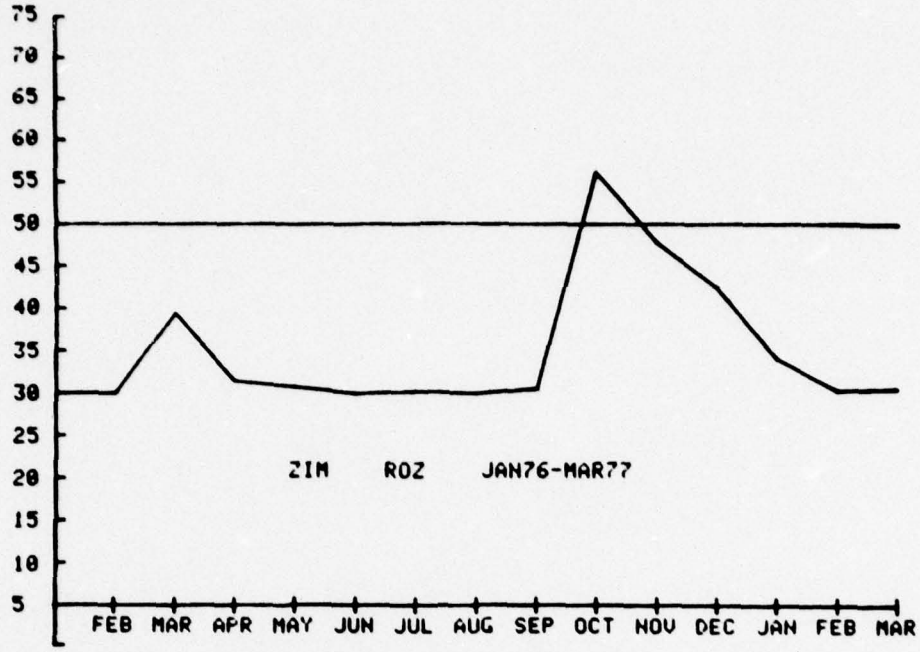


Figure 4-11
ROZ: ZIMBABWE, 1976–1977

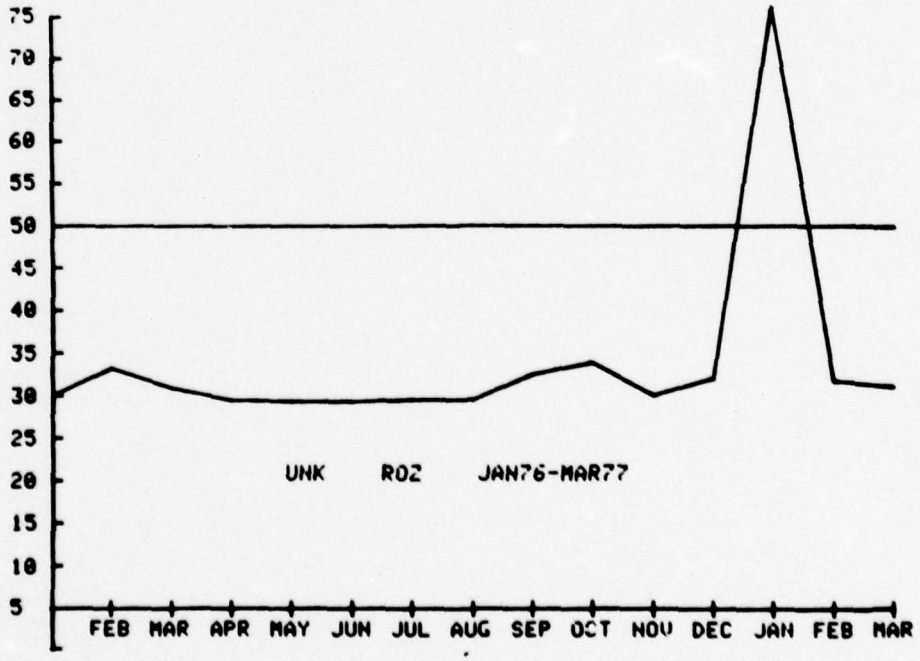
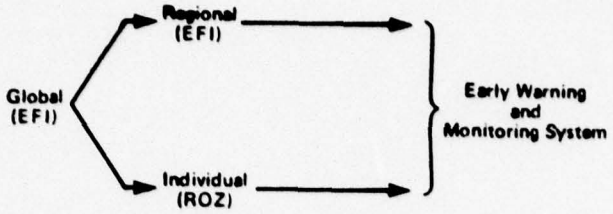


Figure 4-12
ROZ: UNITED KINGDOM, 1976–1977

resident in the prototype. The relationship between these indicator connections is illustrated below:



That EFI can be used on a regional as well as a global level suggests a variation on the preceding option. Based on regional or global EFI scans for threat conditions, the analyst will be able to use ROZ. If an analyst tracking a global EFI detected a change in the nature and direction of international affairs at that level, he could then drop to a regional EFI to determine the region (or regions) responsible for the disturbance or he could go directly to ROZ to determine the specific country. Whether the analyst chose a regional EFI or a ROZ scan, the final step would be to locate the dyad (or perhaps triad) generating the disturbance. This global, regional, and individual country tracking system will permit detection of disturbances long before they evolve into serious international crises.

While more work is needed on both warning and monitoring based on EFI and ROZ initial efforts have demonstrated that they can now serve as useful monitors. Their dual functions will help link the three components of EWAMS. By using EFI as a global system scan to lead into single country or dyadic tracking rather than constantly tracking a large number of country pairs, the analyst makes more efficient use of time and energy.

For analysts with regional concerns, a modified ROZ could serve as the basis of a weekly or daily ranking of the most active members of his region. Analysts with broader

perspectives might use a daily list of the top 50 ROZ's or percentages to monitor and forecast system displacements. ROZ-like indicators might also be developed for military and economic data and used in conjunction with the political ROZ to further enhance our early warning and monitoring capability.

Indicators of Conflict and Cooperation

A salient problem for a political indicator system is that of differentiating among types of crises. A similar problem is that of distinguishing between exercises and actual mobilizations. An early warning and monitoring system that could make an even finer distinction--between "normal" military exercises and those conducted for political purposes--would also be useful. Political indicator systems, whether run in parallel or amalgamated with computer-based military I&W systems, should facilitate an exercise-mobilization distinction. For example, if indicators of a country's political tension as well as indicators of its military activity are increasing, there is a greater likelihood that they are signalling a mobilization than if only military indicators are elevated. Similarly, if only domestic political conflict indicators (not international ones) and military indicators are rising, the military activity may be a signal of preparation for putting down civil strife rather than for military engagement with another country.

In parallel with research on distinguishing between exercises and mobilizations, whether with political indicators, military indicators, or a combination of them, we must continue work on differentiating among types of crises--a problem recently illustrated by the "crisis of cooperation" in the Middle East. An analysis of the political indicators of the Early Warning and Monitoring System

reveals little other than: the nature of UAR-ISR interaction may have begun to change in July; the diversity of USA-ISR interaction and a switch in the US-Soviet relationship vis-a-vis the Mid-East may have contributed to the change. While system indicators continue to monitor the regional breakthrough which began in November 1977, several problems and issues must be discussed before we can determine whether or not the Early Warning and Monitoring System forecasted the cooperative phenomenon.[10]

Over the past fifteen years, the efforts of those working with WEIS, other events data sets, and with crisis concepts have contributed to the development of indicators which can be used to monitor crises as well as international affairs in general. Research in this field has just recently reached the point where these indicators can be evaluated, thresholded, and used to forecast or warn of crisis. The emphasis in the project, as well as in the work of many who have directly or indirectly contributed to it, has been on conflict and crisis. While cooperative phenomena are a component of our indicators, attention to cooperation has been scant. Since we have generally ignored historical cooperation and have done little analysis of its patterns and indicators, we are in no position to set thresholds or to provide advance warnings of major cooperative breakthroughs in the affairs of nations. Recent events in the Middle East have demonstrated the perils of our narrow focus on conflict. They also illustrate monitoring problems of interpretation, targets, and more general issues associated with "crisis." While the impact of recent Middle East events on U.S. national security may not be as dramatic as previous events, e.g., the October War, they may turn out to be much more important to U.S. defense policy in the long run.

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[10] Some of these problems and issues are also discussed in McClelland (1978) as what he aptly calls "the conflict/cooperation trap."

It is likely there is sufficient information in WEIS and other data sets to develop various cooperative indicators and to identify patterns of cooperation. An unanswered empirical question is whether there have been enough "crises of cooperation" to set thresholds for warning and forecasting. The information is there; we have not done enough analysis to know if we can go from monitoring to warning of cooperative breakthroughs, to know if we can solve the problems and issues associated with different types of crises.[11]

Until recently, we considered cooperative activity solely in terms of what it could tell us about potential for ongoing conflict. Cooperation has been treated merely as a component of other indicators of crisis and conflict. This perspective is not wrong, but it is incomplete.[12] It is not profound to say that a breakthrough in Middle East affairs occurred in November 1977--a breakthrough which the Early Warning and Monitoring System recorded accurately. However, system performance also revealed monitoring problems of targets and interpretation and the issues associated with them. For example, should intra-Arab dyads be monitored? Should more attention be paid to the UN and PLO? Should greater weight be given to indicators of superpower-regional power interaction than to indicators of regional power interaction? How much of the US-Israeli conflict signal is noise?

Even given these problems and issues, the system did monitor the November breakthrough in the Middle East.

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[11] See Daly (1978) for a report of an attempt to begin the requisite analysis.

[12] As McClelland discusses and as borne out by our research, cooperation is a component of crisis behavior, and probabilities of conflict can be generated from cooperative z-scores. See McClelland (1972) and Daly and Bell (1977b).

But more importantly, did these problems and others prohibit a forecast? Did the system provide warning of the breakthrough? In terms of the skeletal conceptual relationship of monitoring to warning presented above, the answers to these two questions are respectively yes and no. We have not yet devoted sufficient attention to the evaluation and thresholding components of monitoring nor to the specific issues associated with them. Thresholds have not been set; patterns have not been analyzed for the purpose of providing warning of cooperative breakthroughs between nations; probabilities have not been generated for the purpose of forecasting cooperation. Yet while Monday-morning quarterbacking may seem gratuitous, if such phenomena are to be forecast, history must be searched for patterns which may signal such breakthroughs.

Pre-Crisis Peaks, False Alarms, and Conflict Event Types: Partly in response to the problems revealed by the analysis of the Mid-East crisis of cooperation, new research was undertaken on the cooperative and conflictual indicators. Previous analyses of three crises that were incorporated into the first-stage demonstration system revealed the presence of what has come to be referred to as the "pre-crisis peak" phenomena, i.e., the tendency of the system to register a substantial increase in the probability of a crisis several months prior to the outbreak of the crisis.[13]

Pre-crisis peaks have now been examined and described in three important crises: the 1968 invasion of Czechoslovakia, the 1971 Indo-Pakistani War, and the 1967 Sino-Soviet border clash. Analysis has focused exclusively on exchanges of conflictual events between country-pairs

[13]The three crises included the 1967 Sino-Soviet border clash, the 1968 invasion of Czechoslovakia, and the 1971 Indo-Pakistani war. See Andriole (1976B).

during the months preceding the crisis. Attempts have been made to isolate and identify recurring patterns in both verbal conflictual events and physical conflictual events. The key findings include:

- pre-crisis peaks are dominated by verbal conflict behavior and not physical conflict;
- verbal conflict and physical conflict indicators provide the user with a more complete picture of the developing crisis;
- physical conflict indicators do not appear to produce as many false alarms.

EWAMS takes advantage of several methods to generate indicators of crisis situations. Fundamental to the international political indicators that measure volume, variety, tension, and uncertainty is the distinction between cooperative and conflictual event types. Currently, event types are grouped into conflict and cooperation categories by using the World Event Interaction Survey (WEIS).

In the past, analysts have grouped event types on the basis of characteristics other than cooperation and conflict. Different approaches to grouping events have been proposed to improve the monitoring and warning capabilities of the system (Andriole 1977b). Recent research with events data that categorizes event types by their verbal-physical characteristics, as well as a cooperative-conflictual qualities, suggests that different groupings should be investigated further.[14]

Of particular interest to potential users are research findings which suggest that the character of the conflict between countries is substantially different in

[14] See, for example, McGowan (1976); Calhoun (1977); and McClelland (1970).

crisis and non-crisis periods. Crisis behavior has been discovered to be more sensitive to changes in physical conflict than to fluctuations in verbal conflict. Furthermore, analyses suggest that developments in verbal conflict tend to precede changes in physical conflict and that these developments often occur prior to the outbreak of the crisis (Calhoun 1977; McGowan 1976). It has been suggested that because verbal events require less commitment and involve fewer costs than do physical events, they should follow different patterns.[15]

These research efforts on conflict event types are potentially quite valuable. Above all else, they suggest that monitoring gross conflict levels, without taking into consideration the verbal-physical characteristics of the events, may not be sufficient. If verbal and physical conflict interactions follow different but related patterns, then the monitoring system is failing to take advantage of what may prove to be highly diagnostic pieces of information.

From a warning perspective, pre-crisis peaks in conflictual interactions usually produce false alarms.[16] This is because pre-crisis surges in conflictual activity occur at least two months prior to the outbreak of a crisis. Additionally, the movements are typically dramatic enough to produce substantial increases in the probability of a crisis. Figures 4-13 to 4-15 portray the two-way conflict interaction frequencies along with the conflict probabilities for the three crises. The pre-crisis peak for the 1968 Czechoslovakia crisis occurred in May 1968, three months prior to the invasion in August; the pre-crisis peak for the Indo-

[15] McGowan (1976). For a more complete discussion of supporting theory see McClelland (1970).

[16] A false alarm occurs when an indicator signals a crisis during a month which is neither a crisis month nor a pre-crisis month (one month before). See Daly and Bell (1977a).

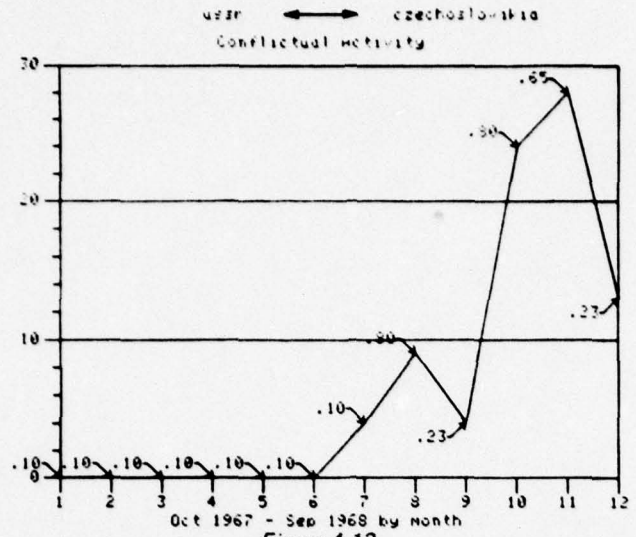

Figure 4-13
SOVIET UNION⟷CZECHOSLOVAKIA: TOTAL CONFLICT

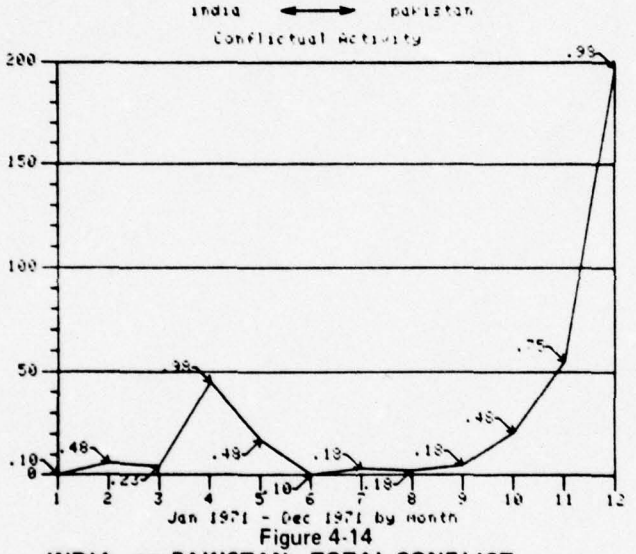

Figure 4-14
INDIA ⟷PAKISTAN: TOTAL CONFLICT

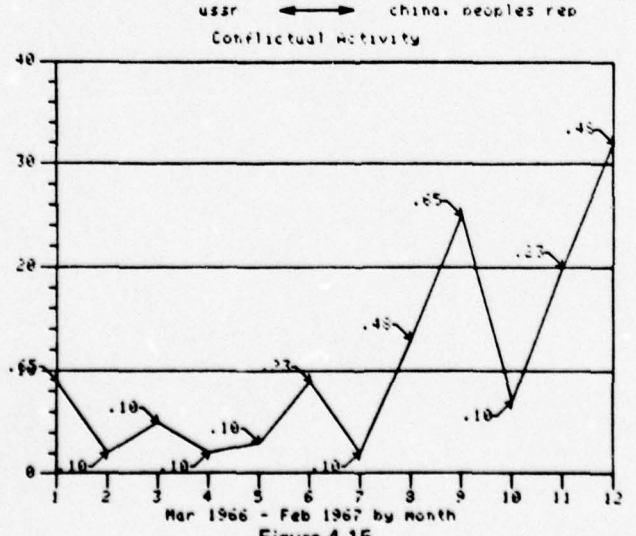

Figure 4-15
SOVIET UNION⟷CHINA: TOTAL CONFLICT

Pakistani crisis in November took place in April 1971, seven months prior to the crisis; and the pre-crisis peak for the Sino-Soviet border clash of January-February 1967 occurred in November of the previous year.[17]

How can the user, in a real-time mode, determine whether upsurges in the number of conflictual interactions and corresponding probabilities reflect "true" crisis situations? Obviously, no definitive solution to this problem presently exists. However, based on the discussion of types of conflictual events, it is suggested that perhaps additional clues could be discovered by examining the type of conflict--verbal and physical--that produced the conflict increases and the subsequent false alarms.[18] To explore this possibility, two new conflict indicators were created. First, an indicator of the frequency of verbal conflict was produced by summing the number of verbal conflict interactions between the country-pairs. The WEIS conflict event categories used were reject, accuse, protest, deny, demand, warn, and threat. Second, a physical conflict indicator was produced following the same procedures for the categories demonstrate, reduce, expel, seize, and force.[19]

The total number of conflictual interactions during these three crisis periods, along with the number of verbal and physical conflict events, are given in Tables 4-4, 4-5, and 4-6. Several patterns are particularly worth noting.

---

[17]Although warning thesholds for the conflict probabilities have yet to be specified, in comparison to the probabilities for the crisis months the pre-crisis peak probabilities are high enough to be considered warnings.

[18]Sometimes a further distinction is made between offensive verbal conflict and defensive verbal conflict, e.g., Kirchner (1976). The usefulness of similar types of categories for warning and monitoring purposes is presently being investigated.

[19]Although these categories are not created by strict mathematical rules, they do fulfill the necessary methodological standards as well as provide a useful viewpoint and frame of reference for the user.

MONTHLY ACTIVITY
October 1967-September 1968
USR◄---Two-Way Flow---►CZE

Date	Conflictual Number	Verbal Con Number	Physical Con Number
Oct 67	0	0	0
Nov 67	0	0	0
Dec 67	0	0	0
Jan 68	0	0	0
Feb 68	0	0	0
Mar 68	0	0	0
Apr 68	4	3	1
May 68*	9	9	0
Jun 68	4	4	0
Jul 68	24	19	5
Aug 68**	28	20	8
Sep 68	13	11	2

*pre-crisis peak
**crisis month

Table 4-4

SOVIET UNION◄►CZECHOSLOVAKIA
TWO-WAY MONTHLY CONFLICT LEVELS
OCTOBER, 1967–SEPTEMBER, 1968

MONTHLY ACTIVITY
January 1971-December 1971
IND◄---Two-Way Flow---►PAK

Date	Conflictual Number	Verbal Con Number	Physical Con Number
Jan 71	0	0	0
Feb 71	6	4	2
Mar 71	4	4	0
Apr 71*	45	38	7
May 71	17	15	2
Jun 71	0	0	0
Jul 71	3	2	1
Aug 71	2	2	0
Sep 71	5	5	0
Oct 71	21	16	5
Nov 71**	55	34	21
Dec 71**	198	14	184

*pre-crisis peak
**crisis month

Table 4-5

INDIA◄►PAKISTAN
TWO-WAY MONTHLY CONFLICT LEVELS
JANUARY, 1971– DECEMBER, 1971

MONTHLY ACTIVITY
March 1966-February 1967
USR◄---Two-Way Flow---►CHN

Date	Conflictual Number	Verbal Con Number	Physical Con Number
Mar 66	9	9	0
Apr 66	2	2	0
May 66	5	5	0
Jun 66	2	2	0
Jul 66	3	3	0
Aug 66	9	7	2
Sep 66	2	2	0
Oct 66	13	9	4
Nov 66*	25	20	5
Dec 66	7	6	1
Jan 67**	20	14	6
Feb 67**	32	21	11

*pre-crisis peak
**crisis month

Table 4-6

SOVIET UNION◄►CHINA
TWO-WAY MONTHLY CONFLICT LEVELS
MARCH, 1966–FEBRUARY, 1967

In each of the pre-crisis peak months, a substantially high proportion of the total conflict is comprised of verbal conflict as opposed to physical conflict. For example, the USR-CZE country-pair exchanged nine conflictual events during May 1968. In comparison to previous levels of conflict between the Soviet Union and Czechoslovakia, the conflict score of nine was high enough to register a probability of .8. However, as the verbal and physical conflict indicators demonstrate, all conflictual interactions between these two countries during this time period were verbal conflict events. In other words, the warning system estimated a .8 probability of a crisis in a month where no physical conflict events occurred.

This same pattern also exists in both the 1971 Indo-Pakistani crisis and the Sino-Soviet border crisis of 1967 (Tables 4-5 and 4-6). The pre-crisis peak month of the Indo-Pakistani crisis was April, when there was an exchange of forty-five conflictual events. However, thirty-eight of these events or 84% were verbal conflict events and only 16% were physical conflict events. Similarly, during the pre-crisis peak month of November for the Sino-Soviet case 80% of the twenty-five conflict interactions were verbal and 20% were physical.

The dynamics of the patterns in verbal and physical conflict interaction during each crisis can be seen in Figures 4-16 to 4-18. These graphs are plots of the three conflict indicators over time. It appears that movements in verbal conflict, with important exceptions, tend to parallel shifts in total conflict much more closely than does physical conflict. This is not too surprising in light of the dominating influence of verbal conflict on the total conflict scores. However, it is critical to take notice of those situations in which physical conflict tends to parallel total conflict, namely in crisis months. In other words,

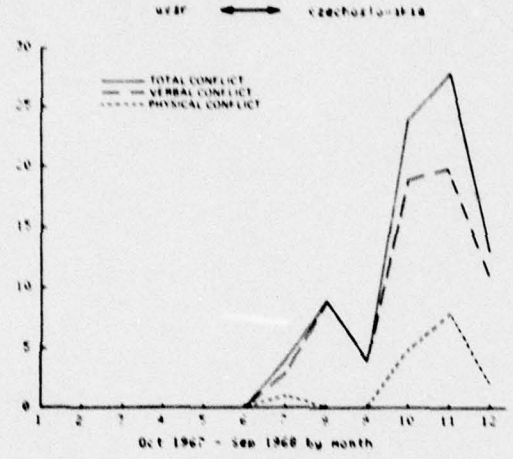

Figure 4-16

SOVIET UNION◄►CZECHOSLOVAKIA: VERBAL, PHYSICAL CONFLICT

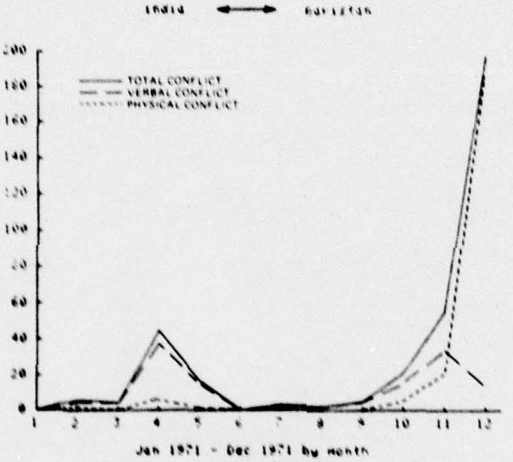

Figure 4-17

INDIA◄►PAKISTAN: VERBAL, PHYSICAL CONFLICT

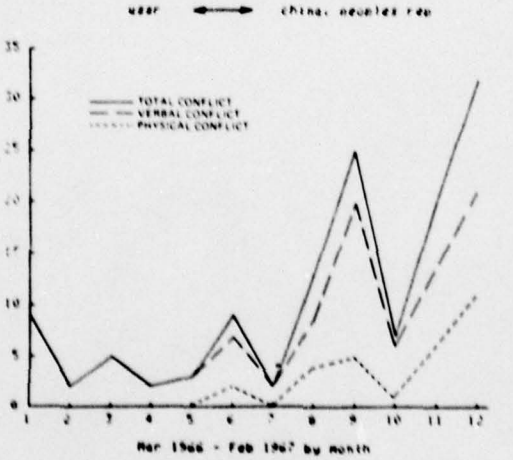

Figure 4-18

SOVIET UNION◄►CHINA: VERBAL, PHYSICAL CONFLICT

physical conflict events appear to reflect the developing crisis situations quite accurately. Whereas verbal conflict events increase dramatically during pre-crisis peaks, producing subsequent false alarms, physical conflict events do not.

Future Research on Conflict Indicators: The preliminary results from this exploratory research effort are very encouraging for a number of reasons. First, the findings strongly suggest that quantitative political indicators of crisis situations derived from characteristics of events other than cooperation and conflict could prove to be quite valuable. In addition to examining the verbal-physical qualities of conflictual events, it is also possible to examine cooperative events in a similar manner. Second, the findings indicate that perhaps a wider variety of information needs to be considered before crisis warnings are given. One alternative may be to provide the user with different types of warnings depending on the type of conflict being exchanged. Another possibility is that an "intelligent" warning system could automatically produce verbal and physical conflict events when the conflict probability crosses a certain threshold.

Several questions need to be considered in future research. For example, how might separate indicators of verbal and physical conflict specifically enhance the monitoring and warning capabilities of the system? How often are pre-crisis peaks produced as a result of verbal conflict in other crises? What about those crises that are not preceded by premature increases in conflictual interactions? If changes in verbal conflict tend to precede changes in physical conflict, how can this finding be used to improve warning time? Do crisis warnings based on physical conflict interactions reduce the number of false alarms

without increasing misses? We are currently exploring several of these possibilities.[20]

Military Indicators

The design for use and integration of military indicators into EWAMS is discussed in Section 3.0. Unfortunately, much of the research done under the terms of the ARPA/DIA MOU and with the great cooperation of DIA/NMIC personnel is classified and cannot be reported in detail here. However, a few summary statements can be made.

Since the inception of the ARPA/CTO EWAMS project, the assumption has been that political indicators will provide earlier warning of international crises than will military indicators. The reasoning has been that conflict, tension, and uncertainty characteristics of a crisis will appear in the political arena before activity in the military sphere begins to deviate from the norm, if indeed it does. It has been presumed that in most cases (successful surprise attacks being the obvious exception), those national decision-makers who control the use of force will (intentionally or unintentionally) reveal their plans, or the potential results of their interactions will appear in the political arena before the military is activated.

The results of other research related to this proposition are mixed. A study of four military and many international political indicators over five and one-half years found "some evidence of consistent and significant relationships" between the two sets, with military ones tending to lead political ones (Calhoun, Weil, and Krysakowski 1974). A study of one year (12/71-12/72) of political and military interaction among North and South Vietnam

[20] Results of tests addressing these questions will be reported in forthcoming research memoranda.

and the U.S. found a variety of associations among concurrent and lagged political and military indicators. The study was not intended as an analysis of warning time provided by the indicators but rather as a description of the interaction among the three countries (CACI 1973). Among the strongest associations were those between U.S. attacks on North Vietnam and on North Vietnamese troops and political hostility from North Vietnam to the U.S. The association held for both the same week and with a lag of U.S. attacks from 1-4 weeks behind North Vietnam political behavior (CACI 1973). There are several unique features of the Vietnam study which prohibit generalization of its findings. However, the first study used indicators and actors fairly similar to those examined in our work at DIA/NMIC. That the findings of that study generally contradict our assumptions is one of several reasons for our ongoing effort.

The purpose of preliminary research is primarily to compare the trends in political and military indicators over a period of time, to look for similarities and differences in the way they monitor international activity. A secondary purpose is to compare their warning performance and the leads and lags between the two types of indicators.

Very preliminary results suggest that military and political indicators are most strongly associated (and monitoring is most congruent) in crisis periods. Furthermore, the assumption that political indicators lead military ones, while not disconfirmed, is far from validated. The authors of the CACI study which found that military indicators led political and military indicators for periods of several years, both concurrent and lagged, are also counter-intuitive.

To date, conclusions of an infant effort are both substantive and methodological. Political and military indicators can be used to monitor, and to some extent provide warning of, major international crises. Methodologically, there are many problems and potential solutions. While solutions may not validate our assumptions, hopefully they will enable us to better understand the behavior of and the relationships between political and military indicators. We must specify the best political indicators to be used for comparison. Perhaps verbal political conflict may be more appropriate than total political activity or conflict in general. We must also manipulate the political data so that it is as comparable as possible to the military data format.

Tracking the political indicators for the same time spans as military indicators in their original form, whether weekly, daily, or bi-weekly, may reveal stronger associations between the concurrent and lagged values. While military indicators are usually based on very rich data, the political data currently in use is best for the U.S.-Soviet pair, which also has the strongest association with the military indicators examined so far. If other military indicators track other countries, country-pairs or regions, other political data sets could be used. In any case, a pilot study comparing public-source-based political indicators, political indicators based on possibly richer cable traffic, and military indicators might be one means of bringing to convergence our assumptions and findings about the relationship between political and military indicators for forecasting and monitoring.

Tension and Thresholds[21]

There have been three thrusts in the research on the international tension measure: (1) modification and

[21]This section relies heavily on Daly and Bell (1977a).

improvement of the basic algorithm; (2) examination of region-specific tension indicators, and (3) exploration of warning thresholds for the indicator.

Results of the research presented below are based on twenty-five "global" crises which occurred between 1966-1975. Tension levels in these crises were altered with several weighting factors, and associations between indicator signals and reality were calculated not only for the weighted tensions across twenty-five crises but also for various warning thresholds for each weight. In conjunction with this research, two interactive programs for weighting tension and for calculating indicator-reality associations were developed on a standalone Tektronix 4051.[22] The key findings are listed below.

- Across twenty-five crises, a tension weighted by 1/f has the strongest association with historical reality; unweighted tension has the weakest.
- A warning threshold of 70 has the highest association for this 1/f weighted tension.
- The indicator-reality association calculation (and standalone interactive program) can be generalized to test other I&W indicators.
- The weighted tension algorithm most useful for general warning and monitoring purposes will not necessarily yield hit/false alarm rates best suited to the requirements of the user community.
  - Hit and false alarm rates can be calculated for any threshold and any weight. The analyst must then choose that mix of rates which best meets the requirements of his responsibility.

Method--Tension: The tension indicator reflects the percent of total events sent and/or exchanged that are cooperative and conflictual. It ranges from 0 to 100 and is

[22]Both programs were written by Brenda Bell.

used to monitor international relations. Increases in the tension indicator are used to provide warning of potential conflict and danger and, once a crisis has begun, to monitor its status.[23] Prior to the research reported in this section, tension was calculated as follows:

CONFLICTUAL BEHAVIOR (CON)

DENOUNCE
ACCUSE
THREATEN . . .

COOPERATIVE BEHAVIOR (CO)

PROPOSE
AGREE
PRAISE . . .

$$\text{TENSION} = \left[\frac{\text{CON} - \text{CO}}{\text{CON} + \text{CO}} + 1\right] \times 50$$

A more straightforward restatement of the algorithm was:

$$\text{TENSION} = \frac{\text{CON}}{\text{TOT}} \times 100$$

This calculation for tension controlled for the total number of events occurring in a time period, e.g., both 10 and 100 events could yield tension levels of 80. It was suggested that the reliability of tension decreased with the number of events. In addition to questionable reliability, tension levels based on small frequencies tended to vary erratically. For instance, when there were less than ten events, tension tended to equal 0, 50, or 100 and to change 100 points from one month to the next. Finally, ". . to fine-tune tension and to make it less dependent on the size of f, some weighting method or 'correction' factor needed to be introduced into the calculation."[24] Now tension is

[23] For more background on the deviation and concept of tension, see Andriole (1976a and 1976b). For illustrations that the tension-conflict association is far from a novel idea, see Holsti (1973 and 1963).

[24] For the source of these suggestions see Parker (1977).

viewed as a function of both the predominance of conflict events compared to cooperative and the total number of events. The earlier tension measure assumed that tension depended strictly on the former consideration.

The first cut at correcting tension was reported in Research Memorandum #9 and was based on the following two-way flows and crisis periods:

ISR-UAR	1/67-12/67 and 1/73-12/73
ISR-SYR	1/67-12/67 and 1/73-12/73
ISR-JOR	1/67-12/67 and 1/73-12/73
ALL-ALL(Middle East)	1/67-12/67 and 1/73-12/73.

The initial weighting factors used were $1/f$, $1/2f$, $1/f^2$, and $1/f+1$. An example of the calculation to weight tension is:

$$Ten_{corrected} = Ten_{raw} - (Ten_{raw} \times 1/f^2)$$

In all cases the weighting factor was subtracted in order to reduce tension scores based on small f's and to have little effect on those based on large f's (Parker 1977).

In order to determine if the first cut results were reliable and generalizable, we expanded the sample from eight regional cases in two crisis periods to twenty-five "global" crises occurring between 1966-1975.[25] These cases are listed in Table 1. We used the same weighting factors and also subtracted them to reduce tension scores based on small f's.

The larger sample yielded a general and reliable tension algorithm which has been incorporated into the

[25]For caveats connected with "global" see Daly and Bell (1977).

master demonstration system of the Early Warning and Monitoring System. It is quite possible that a region-specific tension algorithm will differ from the general one based on twenty-five crises. This possibility is analyzed below by using more Middle East crisis periods and country pairs than were used in the first cut at correcting tension. If it is found that certain regions are more accurately monitored with tension algorithms differing from the general one, an option will be added to the system to allow the analyst to use the general one or, depending on his focus, to use a region-specific one.

Method--Association Between Indicator Signals and Historical Reality: A multi-method approach was employed to evaluate the utility of alternative weighting factors. First, Yule's Q; second, overall success rates; and third, percentages for the possible outcomes. Testing of the weighted tension measures were generated by a standalone interactive program which is generalizable to other indicators. The Yule's Q statistic, a measure of association for two by two tables was used (Leege & Francis 1974; Watts & Wilcox 1966), to compare the warning and monitoring capabilities of the weighting tension levels. Yule's Q is calculated as follows:

		REALITY: Crisis	REALITY: No Crisis
Indicator Signals:	Crisis	a (Hit)	b (False Alarm)
	No Crisis	c (Miss)	d (Correct Rejection)

$$Q = \frac{ad - bc}{ad + bc}$$

with the cells defined as:[26]

HIT — When the indicator signalled crisis either during the crisis month or one month before the crisis began.

MISS — When the indicator did not signal crisis during the crisis month or one month before the crisis.

FALSE ALARM — When the indicator signalled crisis during a month which was neither a crisis month nor a precrisis month (one month before).

CORRECT REJECTION — When the indicator did not signal crisis and there was no crisis during the month.

Yule's Q varies from -1 to +1 with the best weighting factor yielding the highest positive value. A +1.0 means there is a perfect linear association between what the indicators have signalled and reality. That is, if the indicators accurately record all hits and correct rejections, Q=+1.0. A -1.0 suggests there is a negative relationship between the indicator signals and reality, i.e., they have always missed or false alarmed. There are some caveats to be offered, especially when the analyst is calculating Q over a small number of cases. If there are either no false alarms and some misses, or vice versa, Q will still equal 1.0.[27]

Since some analysts will prefer to work with and to evaluate the indicators in terms of percentages of hits, misses, and false alarms rather than an overall association between reality and indicator signals, the program will also calculate these percentages over crises of the analyst's choice.

---

[26] Counts of hits, misses, and false alarms take into consideration the one-month period prior to the crisis. Since our intention is to eventually monitor on a weekly and daily basis, we feel that one month's lead is both adequate and realistic.

[27] The program quickly displays a table which the analyst can examine to determine if a Q = 1.0 is reflecting perfect

Results--Associations: The Yule's Q for various weights and warning thresholds across twenty-five crises are presented in Table 4-7. Unweighted tension has the weakest Yule's Q, while tension weighted with 1/f has the strongest. As will be discussed in detail below, it also has the highest percentage of hits and correct rejections. Tension levels weighted by this factor have been incorporated into the master version of the demonstration system. The new algorithm is:

$$\text{TENSION} = \left[\frac{\text{CON}}{\text{TOT}} - \frac{\text{CON}}{\text{TOT}^2}\right] \times 100$$

Or, more simply:

$$\text{TENSION} = \frac{\text{CON}}{\text{TOT}}\left[1 - \frac{1}{\text{TOT}}\right] \times 100$$

Some idiosyncracies of this algorithm include:

- TEN = 0 when there are 0 events;
- TEN = 0 when there is one event and it is cooperative; and
- TEN has been hardwired to 28 when there is one event and it is conflictual.

For a 1/f weighted tension, a warning threshold of 70 has the highest association with historical reality (.599). As will be indicated shortly, more work has been and needs to be done on thresholds and hit/false alarm rates for tension as well as other indicators. In the interim, a tension level of 70 might serve as a useful reference point for analysts.

The impact of weighting tension can be illustrated by a comparison of the old and new algorithms for accuracy of the indicators or 0 in the false alarm or miss cells. Analyses carried out for twenty-five crises suggests that a high negative Yule's Q usually indicates a high false alarm rate rather than many misses.

PROCESSING....

JOR<<<>>>SYR JAN 1966 - DEC 1966
JOR<<<>>>PLO JAN 1966 - DEC 1966
JOR<<<>>>ISR JAN 1967 - DEC 1967
ISR<<<>>>SYR JAN 1967 - DEC 1967
ISR<<<>>>UAR JAN 1967 - DEC 1967
JOR<<<>>>ISR SEP 1967 - AUG 1968
ISR<<<>>>UAR JAN 1969 - DEC 1969
ISR<<<>>>SYR JAN 1969 - DEC 1969
JOR<<<>>>SYR JAN 1970 - DEC 1970
JOR<<<>>>PLO JAN 1970 - DEC 1970
ISR<<<>>>SYR JAN 1970 - DEC 1970
USA<<<>>>SYR JAN 1970 - DEC 1970
ISR<<<>>>UAR JAN 1973 - DEC 1973
ISR<<<>>>SYR JAN 1973 - DEC 1973
USR<<<>>>USA JAN 1973 - DEC 1973
USR<<<>>>CHN AUG 1966 - JUL 1967
GRC<<<>>>TUR JAN 1967 - DEC 1967
TUR<<<>>>CYP JAN 1967 - DEC 1967
USR<<<>>>CZE JAN 1968 - DEC 1968
USA<<<>>>KON AUG 1967 - JUL 1968
USR<<<>>>CHN JAN 1969 - DEC 1969
USA<<<>>>USR JAN 1970 - DEC 1970
IND<<<>>>PAK JUN 1971 - MAY 1972
GRC<<<>>>TUR JAN 1974 - DEC 1974
TUR<<<>>>CYP JAN 1974 - DEC 1974

YULE S Q FOR TENSION

Crisis Threshold	Raw Tension	1/f	1/2f	1/ft2	1/f+1	Average
90	0.435	0.554	0.455	0.580	0.496	0.504
85	0.495	0.574	0.559	0.466	0.532	0.525
80	0.459	0.496	0.456	0.492	0.538	0.488
75	0.491	0.537	0.527	0.520	0.527	0.520
70	0.482	0.599	0.490	0.461	0.544	0.515
Average	0.473	0.552	0.498	0.504	0.528	0.511

Table 4-7

YULE'S Q FOR TENSION OVER 25 CRISES

three crisis cases. Table 4-8 shows the old or unweighted algorithm under "TENSION," the total number of events on which the calculation is based, and the effect of weighting by one divided by the total for India-Pakistan. The crisis months were November-December 1971, and the first observation on the columns is June 1971. The weighted tension is generally lower and less erratic than the unweighted. Both indicators provide warning of and monitor the crisis. However, weighted tension is not characterized by the extreme scores of 100 in July and August (based respectively on only three and two events) which appear in the unweighted tension and which, since they were followed by a 30-point drop in one month, might have led an analyst to believe that potential conflict had been averted.

Table 4-9 encompasses the Soviet-Chinese border dispute of January-February 1967. Weighted tension is lower and more consistent than unweighted. Both tensions warn of and monitor the crisis period, while weighted is much better at recording the winding down of the confrontation with its smaller number of events.

Neither the weighted nor the unweighted tension for the Soviet invasion of Czechoslovakia broke the recommended warning level of 70 in the crisis year (Table 4-10). While the tension algorithms fail in this specific case--a result of the relatively large percentage of cooperative events in the period which perhaps reflect Soviet deception and Czech attempts to avoid and then mitigate USSR action--this should not be viewed as a failure of the tension indicator in general. The Yule's Q average for twenty-five cases indicates that tension can be a useful and revealing indicator for monitoring and warning. It would be possible to develop dyad-specific tension algorithms which would work for historical cases. However, since many country-pairs have been involved in only one crisis, e.g., USR-CZE, this would mean

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UNCLASSIFIED PR-78-17-39 NL

2 OF 3
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**** TENSION LEVELS ****
JUN 1971 - MAY 1972
IND<<<>>>PAK

Total	Conflictual	Tension
0	0	50.000
3	3	100.000
2	2	100.000
7	5	71.429
22	21	95.455
60	55	91.667
218	198	90.826
10	3	30.000
17	8	47.059
10	9	90.000
17	1	5.882
8	4	50.000

Tension	F	1/f	1/2f	1/f+2	1/f+1
50.000	0	0.000	0.000	0.000	0.000
100.000	3	66.667	83.333	88.889	75.000
100.000	2	50.000	75.000	75.000	66.667
71.429	7	61.224	66.327	69.971	62.500
95.455	22	91.116	93.285	95.257	91.304
91.667	60	90.139	90.903	91.641	90.164
90.826	218	90.409	90.617	90.824	90.411
30.000	10	27.000	28.500	29.700	27.273
47.059	17	44.291	45.675	46.896	44.444
90.000	10	81.000	85.500	89.100	81.818
5.882	17	5.536	5.709	5.862	5.556
50.000	8	43.750	46.875	49.219	44.444

Table 4-8

INDIA<→PAKISTAN
MONTHLY TENSION LEVELS
JUNE, 1971–MAY, 1972

**** TENSION LEVELS ****
AUG 1966 - JULY 1967
USR<<<>>>CHN

Total	Conflictual	Tension
10	9	90.000
2	2	100.000
14	13	92.857
26	25	96.154
7	7	100.000
20	20	100.000
35	32	91.429
9	9	100.000
4	3	75.000
4	4	100.000
5	5	100.000
3	3	100.000

Tension	F	1/f	1/2f	1/f+2	1/f+1
90.000	10	81.000	85.500	89.100	81.818
100.000	2	50.000	75.000	75.000	66.667
92.857	14	86.224	89.541	92.383	86.667
96.154	26	92.456	94.305	96.012	92.593
100.000	7	85.714	92.857	97.959	87.500
100.000	20	95.000	97.500	99.750	95.238
91.429	35	88.816	90.122	91.354	88.889
100.000	9	88.889	94.444	98.765	90.000
75.000	4	56.250	65.625	70.313	60.000
100.000	4	75.000	87.500	93.750	80.000
100.000	5	80.000	90.000	96.000	83.333
100.000	3	66.667	83.333	88.889	75.000

Table 4-9

SOVIET UNION<→CHINA
MONTHLY TENSION LEVELS
AUGUST, 1966–JULY, 1967

****** TENSION LEVELS ******
JAN 1968 - DEC 1968
USR<<<>>>CZE

Total	Conflictual	Tension
1	0	0.000
2	0	0.000
5	0	0.000
8	4	50.000
21	9	42.857
12	4	33.333
37	24	64.865
48	28	58.333
41	13	31.707
21	5	23.810
11	7	63.636
10	2	20.000

Tension	F	1/f	1/2f	1/f↑2	1/f+1
0.000	1	0.000	0.000	0.000	0.000
0.000	2	0.000	0.000	0.000	0.000
0.000	5	0.000	0.000	0.000	0.000
50.000	8	43.750	46.875	49.219	44.444
42.857	21	40.816	41.837	42.760	40.909
33.333	12	30.556	31.944	33.102	30.769
64.865	37	63.112	63.988	64.817	63.158
58.333	48	57.118	57.726	58.308	57.143
31.707	41	30.934	31.321	31.688	30.952
23.810	21	22.676	23.243	23.756	22.727
63.636	11	57.851	60.744	63.110	58.333
20.000	10	18.000	19.000	19.800	18.182

Table 4-10

SOVIET UNION◄►CZECHOSLOVAKIA
MONTHLY TENSION LEVELS
JANUARY–DECEMBER, 1968

generalizing from one case. A tension algorithm based on as large a sample as possible will be more reliable and valid for a monitoring and warning system which is both global and "real time."

Results--Hit/False Alarm Rates: For the analyst interested in general warning and monitoring, who is not interested in empiricially established thresholds but who would rather base them on his own expertise, 1/f weighted tension is the most reliable tension indicator. As indicated in Table 4-11, the weight has, when calculations are over several thresholds, the highest percentage of "successes" (Hit + Correct Rejection = 75.87%). For the analyst interested in a general reference threshold with the strongest association with historical reality, Table 4-12 illustrates that 70 for 1/f is preferable, based upon a success rate of 73.33%.

However, the responsibility of some analysts might dictate a greater concern with false alarm percentages than with general associations of indicator signals and reality. For those analysts, other weight-threshold combinations might be more suitable. While the 1/f weighted tension with a 70 threshold has both the highest Yule's Q and the highest success rate, this is not always the case for other thresholds. Furthermore, the responsibilities of some analysts might render a false alarm rate of 17.67 unacceptable. For these analysts, Table 4-13 presents some alternatives. While the general overall performance of a 90 threshold and weights of 1/f or $1/f^2$ are not as strong as 70 and 1/f, they do reduce the false alarm percentages and increase the sum of hits and correct rejections (79.0 and 76.34 respectively). Part of the price for this is a reduction in hits and an increase in misses.

*** YULE'S Q FOR TENSION ***

CRISIS THRESHOLD	RAW TENSION	1/F	1/2F	1/F**2	1/F+1	AVERAGE
90	0.435	0.554	0.455	0.500	0.496	0.504
85	0.495	0.574	0.559	0.466	0.532	0.525
80	0.459	0.496	0.456	0.492	0.538	0.488
75	0.491	0.537	0.527	0.520	0.527	0.520
70	0.482	0.599	0.490	0.461	0.544	0.515
AVERAGE	0.473	0.552	0.498	0.504	0.528	0.511
False Alarm	28.73%	12.20%	17.47%	19.33%	14.13%	
Miss	7.53%	11.93%	10.60%	9.07%	11.47%	
Hit	11.47%	7.87%	8.40%	9.13%	7.53%	
	63.74%	75.87%	71.93%	70.80%	74.40%	
Correct Rejection	52.27%	68.00%	63.53%	61.67%	66.87%	

Table 4-11

YULE'S Q AND PERCENTAGES OVER 25 CRISES

*** YULE'S Q FOR TENSION ***

CRISIS THRESHOLD	RAW TENSION	1/F	1/2F	1/F**2	1/F+1	AVERAGE
70	0.482	0.599	0.490	0.461	0.544	0.515
False Alarm	33.33%	17.67%	24.67%	26.00%	20.00%	
Miss	6.33%	9.00%	8.33%	8.33%	9.00%	
Hit	12.67%	10.00%	10.67%	10.67%	10.00%	
	60.34%	73.33%	67.00%	65.67%	71.00%	
Correct Rejection	47.67%	63.33%	56.33%	55.00%	61.00%	

Table 4-12

PERCENTAGES OF A 70 THRESHOLD OVER 25 CRISES

*** YULE'S Q FOR TENSION ***

CRISIS THRESHOLD	RAW TENSION	1/F	1/2F	1/F**2	1/F+1	AVERAGE
90	0.435	0.554	0.455	0.500	0.496	0.504
False Alarm	24.67%	6.33%	10.33%	12.33%	7.33%	
Miss	9.00%	14.67%	13.67%	11.33%	14.67%	
Hit	10.00%	4.33%	5.33%	7.67%	4.33%	
	66.33%	79.00%	76.00%	76.34%	78.00%	
Correct Rejection	56.33%	74.67%	70.67%	68.67%	73.67%	

Table 4-13

PERCENTAGES OF A 90 THRESHOLD OVER 25 CRISES

The analyst, with his unique expertise and responsibility, must decide what mix of general reliability and percentage of hits, misses, and false alarms is best addressed to his task. We can provide data on which he can base his decision and help evaluate its consequences. EWAMS can supplement his expertise by making him more efficient and organizing his information. Only he can decide which thresholds and hit/false alarm rates are best suited to his needs.

Tension--Future Research: The tension indicator algorithm in the master version of EWAMS has been changed to the algorithm weighting it for 1/total number of events. This will reduce tension scores based on a small number of events and provide the analyst with an indicator which better reflects the true state of affairs. It will also provide the analyst with a reference warning threshold of 70-75 as a "best guess." Tension thresholds greater than this slightly increase his chances of missing and decrease the hit rate.

Research is now being done on generating probabilities of conflict and crisis with the weighted tension. Of course, this could be done by simply dividing the tension scores by 100. However, surveying the scores for twenty-five crises suggests such probabilities could be too high and could lead to a high false alarm rate. Probabilities based on straight transformation of tension levels over 70 would result in more misses and false alarms than might be the case if another method of deriving probabilities from tension were developed. The first such attempt will generate progressive z-scores for the new tension algorithm and calculate probabilities from them as done for total, conflictual, and cooperative activity (Daly and Bell 1977b).

The tension indicator is a prime candidate for the blend of subjective and objective I&W indicators. Since EWAMS has just begun running on a "real-time" basis with daily updates, assessments of country-pair tension can be elicited (perhaps via the ARPANET every morning) from experts in State or DoD. These could then be compared with the empirically generated tension levels. This cross-checking could validate or modify the two methods of generating tension indicators. It would also be useful as one more component of a more comprehensive integration of subjective and objective indicators for I&W. Finally, when a sufficiently long time series of expert tension assessments had been accumulated, it might be possible to develop dyad-specific tension algorithms which could then be incorporated into the master Early Warning and Monitoring System.

This method of examining hit/false alarm rates involves the use of decision-analytic likelihood ratios and receiver operating characteristic (ROC) curves (Green and Swets 1966). The method is attractive since it can be applied to probabilities generated by either empirical or personal means. A likelihood ratio is a number expressing the ratio of the probabilities (which could be generated by an expert or empirically) of an event (e.g., a crisis) under two or more hypotheses (for example, a z-score for conflictual activity of 6 versus one of 10). Various likelihood ratios can be plotted as ROC curves as the probabilities used to calculate the ratios are altered. For our purposes they are altered, either by an expert or empirically, by changing the z-score or tension thresholds for signalling crisis. For example, a high threshold will have a high likelihood-ratio criterion and low probability of both hits and false alarms. As the likelihood ratio criterion decreases, hit and false alarm rates will increase and the slope of the ROC curve will decrease.

ROC curves will permit analysts to determine acceptable hit/false alarm rates and to set thresholds accordingly. This option should be attractive to potential users since it is likely that acceptable hit/false alarm rates vary with analyst and command level.

EWAMS will eventually utilize a great number of indicators. In order to evaluate the utility of these indicators it will be necessary to calculate Q values, cell percentages, and success rates, for each indicator separately, for all the indicators combined, and for different combinations of the indicators. We can then determine the usefulness of including certain indicators or certain combinations of indicators in the system. It may be that some indicators are not useful since they "cry wolf" too often even though they often "hit."

The necessity of selecting cases for the tests and for the generation of probabilities is a very important consideration. One could set the indicator thresholds at the same level for all countries, then calculate Yule's Q, hit and correct rejection percentages, probabilities, and likelihood ratios. This assumes that all countries act generally the same before and during crises. The other extreme is setting thresholds for each country individually and calculating Q values, percentages, probabilities, and likelihood ratios for each individual country. This would assume that all countries are unique and that accurate forecasting requires that the analyst consider each country separately. Both extremes present problems. Using all countries together may obscure differences between countries and thus distort forecasting results. For example, it may be that a political stability indicator threshold should be set much higher for a South American country (where stability is usually low and fluctuates widely) than for some Western European countries (where stability is generally high).

Setting the thresholds at the same level for all countries may thus hinder good forecasting. On the other hand, if one chooses to set threshold levels for each individual country, one runs into data problems. Very few countries have been involved in enough crises to generate sufficient data to warrant making forecasts about their future crisis behavior. With the exception of certain Middle East countries, no country has more than a few crisis months from which to generalize. Attempting to calculate Q values, percentages, probabilities, and likelihood ratios for such countries would prove unfruitful and would most likely cause distortion.

Regional Tension--A Middle East Case Study:

Despite the encouraging results of testing the tension indicator across twenty-five global crises, it was felt that the conflict and tension which has historically characterized the Middle East suggested a strong possibility that a region-specific algorithm and threshold would differ from a global one.

Additional reasons for focusing on a regional subsystem as opposed to the international system as a whole or the actions of one or two nations are given by Thompson (1973):

- A regional focus reduces the complexity associated with the international system.
- A regional focus uses boundaries which are based on common usage and empirical reality.
- A regional focus encourages the integration of area specialists and international relations students.
- A regional focus provides the basis for comparative analysis.

To these we can add a fifth reason:

- Regions may have unique interaction patterns not observable by either a systemic or dyadic analysis.[28] To the extent this is so, we can improve our indicators for early warning and monitoring.

Thus, by focusing on a regional subsystem, we can simplify an analytical focus and at the same time perhaps discover something unique and important about a part of the international system.

Why the Middle East? The five general rationales for focusing on regional subsystems yield several specific rationales for examining the Middle East and its crises in terms of the tension indicator. First, in terms of the complementarity of the research of area specialists and international relations analysts, the October War demonstrated, with an oil embargo and superpower confrontation, that subordinate system politics can intrude on broader international system politics as well as vice versa. Thus, "second order crises"[29] may have more dangerous results than the regional crises that trigger them.

Second, in terms of the benefits of comparative analyses, a study of the Middle East system and its crises can serve as the basis for comparison and evaluation of a system for monitoring international or subordinate system relations and forecasting crises. If comparison reveals that an indications and warning system performs better in one region than in another, the system can be modified or made more flexible. Modifications and improvements based on such comparisons are not only aesthetically and intellectually pleasing, they are helpful to users who may be tasked with providing warning of second order crises.

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[28] For a look at Middle East crises from a system perspective, see McClelland (1977 and 1976).

[29] This notion is ably illustrated by Belden (1977).

Third, in contrast to the above report on the performance of the tension indicator over twenty-five "global" crises occurring between 1966-75 and the development of a tension algorithm to be used when the analyst's focus is a general one, the research was addressed to developing a tension algorithm which would monitor Middle East interaction and warn of crises in the region better than would the general algorithm. By improving the warning and monitoring performance of the indicator, a region-specific tension algorithm could be very useful to those in the I&W community focusing on the Middle East.

The tension and Yule's Q programs used in this research are fully described above. For the Mideast research, unweighted and weighted tensions were calculated over various combinations of fourteen Middle Eastern crises.[30] The country pairs and crisis years are presented in Table 4-14. The USA was the only non-regional actor included in the analysis. The four combinations of Middle East crises examined were: all fourteen, all except USA-SYR, all Arab-Israeli, and the 1967 and 1973 wars.

JOR<<<>>>SYR JAN 1966 - DEC 1966
JOR<<<>>>PLO JAN 1966 - DEC 1966
JOR<<<>>>ISR JAN 1967 - DEC 1967
ISR<<<>>>SYR JAN 1967 - DEC 1967
ISR<<<>>>UAR JAN 1967 - DEC 1967
JOR<<<>>>ISR SEP 1967 - AUG 1968
ISR<<<>>>UAR JAN 1969 - DEC 1969
ISR<<<>>>SYR JAN 1969 - DEC 1969
JOR<<<>>>SYR JAN 1970 - DEC 1970
JOR<<<>>>PLO JAN 1970 - DEC 1970
ISR<<<>>>SYR JAN 1970 - DEC 1970
USA<<<>>>SYR JAN 1970 - DEC 1970
ISR<<<>>>UAR JAN 1973 - DEC 1973
ISR<<<>>>SYR JAN 1973 - DEC 1973

Table 4-14
MIDDLE EAST CRISIS CASES

[30] Delineation of crisis actors and periods is based on Moore (1975) and Butterworth (1976).

The results[31] suggest a Mideast-specific tension algorithm for improved monitoring of Middle East political interactions and for more reliable and accurate warning of regional crises. The results also suggest a warning threshold for that algorithm. Finally, for Middle East analysts more concerned with hit and false alarm rates than with general indicator-reality associations, the research yields a variety of options from which he can choose. The key findings are that:

- Tension weighted by $1/f^2$ is the most general reliable tension algorithm for the Middle East. For that weight, the tension algorithm would be:

$$\text{TENSION} = \left(\frac{\text{CON}}{\text{TOT}} - \frac{\text{CON}}{\text{TOT}^3}\right) \times 100$$

- For that weight, 75 is the most useful warning threshold.
- There are a variety of options available to the analyst concerned with hit and false alarm rates.

While we cannot claim to have discovered an interaction pattern unique to the Middle East, the preceding has indicated that the region is best monitored with a tension indicator different from the global measure. It is not surprising, given Middle East history, that the reference threshold for the region is higher than the global one. The tension measure with the strongest indicator-reality association for twenty-five non-region-specific crises is $1/f$ with a reference threshold of 70. (Daly and Bell 1977a) The strongest overall association for the Middle East is provided by a $1/f^2$ weight with a reference threshold of 75. The analyst concerned with general associations would therefore use different algorithms and reference thresholds for global and Middle East tracking.

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[31] For details of results and analyses see Daly (1977a).

The next step is to do cross-regional comparisons. Given constraints of data and current history, the most likely candidate is Africa. Research should be done to determine if, and if so, why and how, an African tension algorithm will differ from a global and Mideastern measure. Hopefully, payoffs from such research will include not only improved performance of the tension indicators(s) per se, but also generation of reliable probabilities of conflict and crisis from the tension measure (Daly and Bell 1977a).

Finally, while this research has suggested, in terms of indicator-reality signals, a Mideast-specific tension algorithm, it also indicates that the expertise and responsibility of the analyst must be the final arbiter, based on tolerable hit/false alarm rates, of the weight/threshold combination to be used in monitoring. Whatever the analyst's choice, the Mideast-specific tension algorithm and several hit/false alarm rate options should facilitate and improve his monitoring and warning for the region.

Weighting Tension--An Examination of Cell Frequencies:[32] Discussion of our research on tension with potential users revealed that we needed to do more work on thresholds and hit rates. This section reports the results of that effort.

When an I&W analyst uses the Early Warning and Monitoring System to assist his judgment on the likelihood of conflict, there are four potential outcomes. He may hit, miss, false alarm, or correctly reject the possibility of a crisis.[33] A series of tests were called for on the tension algorithm weighted by 1/f and the effect of the weighting on

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[32]This section borrows heavily from Davies (1977).

[33]For a description of these outcomes see Daly and Bell (1977a).

the probability of the four possible outcomes. A detailed comparison was made between the raw tension measure and the 1/f tension measure for various thresholds. The Israeli-Syria crisis of June 1967 was used to illustrate some key points, while twenty-five historical crisis cases occurring between 1966-1975 served as the basis for several generalizations. Key findings and implications of this research include:

- Weighting the raw tension measure by 1/f and increasing the tension threshold have similar effects on the type of warning. Both result in fewer predictions of crisis.
- Row percentages allow the analyst to reassess the performance of the different tension measures depending on his preferences for each type of outcome.
- Of those monthly observations which are reclassified as a consequence of weighting the tension measure by 1/f, an average of 79% are reclassified correctly.
- The consequence of using a 1/f weight is the same across almost all tension threshold values. Once differences in the number of crisis and no crisis predictions are taken into account, the effect of 1/f is to increase the percentage of hits and misses, and decrease the percentage of false alarms and correct rejections.

Weighting the raw tension value by 1/f (as is now done in EWAMS) decreases the value of tension for all observations. This can be seen in Table 4-15 which presents the monthly unweighted and 1/f weighted tension values for the two-way flow of events between Israel and Syria during the period January 1967 to December 1967. The size of the reduction in each month is dependent, in part, on the total number of events in that month.[34] For the same raw tension value, the smaller the number of total events the greater the size of the decrease.

[34]The absolute size of the decrease is a function of both the number of events and magnitude of the original

Month	Total No. Events	Unweighted Tension	1/f Tension
January	27	77.78	74.89
February	5	100.00	80.00
March	0	50.00	0
April	10	100.00	90.00
May	2	100.00	50.00
June	26	80.76	77.66
July	8	75.00	65.62
August	0	50.00	0
September	1	100.00	0
October	1	100.00	0
November	3	100.00	66.60
December	0	50.00	0

Table 4-15

ISRAEL-SYRIA, 1967
75 THRESHOLD

Of primary interest is the effect of such a weighting scheme on the warning and monitoring capabilities of the tension measure. In previous testing of the effects of several possible weighting formulas on monitoring and warning capabilities, two measures of performance were examined--Yule's Q and the overall percentage of successes (Daly and Bell 1977a). Across both of these criteria, Yule's Q and the percentage of outcomes which were hits and correct rejections, the 1/f weight consistently outperformed the raw tension measure in providing warning of impending crises. However, with both Yule's Q and hit/false alarm rates based on the total number of observations, problems do arise for ongoing warning situations.

Yule's Q is problematic for several reasons, but especially troublesome is the fact that it can take on a value of +1 when there is not a perfect correspondence between indicator warning and reality.[35] That this is the case can be seen in Tables 4-16 and 4-17 which depict the correspondence, at a threshold of 75, between indicator warning and reality for Israel and Syria. Although the

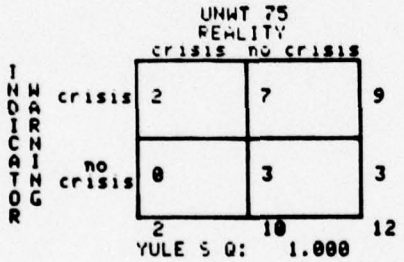

Table 4-16

**ISRAEL-SYRIA, 1967
UNWEIGHTED TENSION
75 TENSION THRESHOLD**

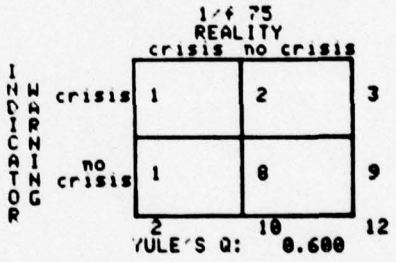

Table 4-17

**ISRAEL-SYRIA, 1967
1/f WEIGHTED TENSION
75 TENSION THRESHOLD**

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tension value. When expressed as a percentage of the original tension value, the decrease is strictly a function of the total number of events.

[35]This possibility is also discussed by Daly & Bell (1977a).

Yule's Q for Table 4-16 takes on a value of +1.0, there is not a perfect association between the indicator warnings and reality. The effect of the seven false alarm predictions is negated by the zero number of misses. Additionally, although the Yule's Q for Table 4-16 indicates a greater similarity between indicator warning and reality than that which exists in Table 4-17, this is not reflected in the overall number of successes for the two tables. For this particular crisis, the Yule's Q criterion might lead an analyst to the conclusion that the raw tension measure is a better warning measure. On the basis of the overall number of successes, however, the 1/f weight appears to be the algorithm which provides the best warning.

In addition to problems with using Yule's Q as a measure of performance of a tension algorithm, caution must also be used in employing percentages which are based on the total number of observations. Total percentages are influenced by two different factors. First, they are sensitive to the probability that a certain <u>type</u> of <u>warning</u> will be made by the indicator signals. Second, total percentages are affected by the probability that a <u>type</u> of <u>event</u> will follow the warning given. A total hit percentage, for example, is a summary measure of the probability that a crisis warning will be given <u>and</u> the probability that a crisis follows this warning.

Because total percentages are equally sensitive to both these factors, it is possible to have a situation in which one tension measure does much better than a second one in predicting crises, yet this is not reflected in the total percentages. As an example of this possibility, consider the following. Suppose monthly forecasts were made over two one-year periods. Over the first twelve months, there were six hits or 50% of the total number of predictions were hits. In the second year, twelve monthly predictions were again made but only four hits occurred for a total hit

percentage of 33%. On the basis of these two yearly hit percentages, the performance of the warning system appears to have been much better in the first year than in the second. What is not controlled for, however, is the number of times a crisis prediction was made or the probability of a crisis warning in each of the two years. In year one, a crisis could have been predicted for eleven months, whereas in the second year, a crisis could have been predicted only four times. Consequently, hits would be much more likely in year one because a crisis prediction was made almost three times as often as it was in the second year.

To adjust the total hit percentages so that differences in the number of crisis predictions in each year are not influencing the performance of the warning system, it is necessary to divide the total hit percentage by the percentage of times a crisis prediction is made. This procedure is equivalent to dividing the number of times a hit is made by the number of times a crisis is predicted, resulting in row percentages (see Tables 4-18 and 4-19). Once the total percentages have been adjusted, this produces a year one hit percentage of 55% and a year two hit percentage of 100%. In year one, of the number of times a crisis is predicted, 55% result in hits. Of the four times a crisis is predicted in year two, 100% result in hits. When the unequal number of crisis predictions is controlled for, the hit performance of the warning system in the second year is <u>better</u> than its performance in the first.

If the row totals--that is the number of crisis and no crisis predictions in Figure 4-19--are different, this indicates that certain outcomes have a higher probability of occurring. To take into consideration this inequality and its influence on the number of hit, false alarm, miss, and correct rejection outcomes, each cell frequency must be divided by the row totals to give row percentages. The row

		REALITY: Crisis	REALITY: No Crisis	
INDICATOR WARNING: Crisis		6 (55%)	5 (45%)	11
INDICATOR WARNING: No Crisis		0 (0%)	1 (100%)	1
		6	6	12

Table 4-18
YEAR ONE

		REALITY: Crisis	REALITY: No Crisis	
INDICATOR WARNING: Crisis		4 (100%)	0 (0%)	4
INDICATOR WARNING: No Crisis		0 (0%)	8 (100%)	8
		4	8	12

Table 4-19
YEAR TWO

		REALITY: Crisis	REALITY: No Crisis
INDICATOR WARNING: Crisis		HIT	FALSE ALARM
INDICATOR WARNING: No Crisis		MISS	CORRECT REJECTION

Figure 4-19
TYPES OF OUTCOME

percentages provide an assessment of the probability of an outcome given an indicator signal of either crisis or no crisis.

The 1967 Israel-Syria Case: The importance of controlling for differences in the number of crisis and no crisis predictions by computing row percentages can be seen in the Israeli-Syrian crisis of 1967. By using the observations presented earlier in Table 4-15, each month between January and December for the Israel-Syria country-pair was classified according to whether or not a crisis occurred, what type of warning was given for that particular month and by the outcome for both the unweighted raw tension measure and the 1/f weighted one. The results of this operation, using a threshold value of 75, are given in Table 4-20. Overall, the effect of the 1/f weighted tension is to change the indicator signals for six months. Each reclassification involves a shift in the signals from crisis to no crisis. Of the six changed months 83% (January, July, September, October, November) are reclassified accurately to correct rejections. One month, May, is reclassified incorrectly from a crisis to a miss.

Tables 4-21a through 4-21d display each outcome frequency in the Israel-Syria case as percentages for both the raw and weighted tension.[36] Tables 4-21a and 4-21b, which percentagize each cell frequency on the basis of the total number of predictions, indicate that when the percentage of overall successes is considered the weighted tension outperforms the unweighted indicator (75% success for 1/f and 42% success for the raw tension).

[36]The interactive program for making these calculations on a standalone Tektronix 4051 was written by Brenda Bell and Don Harrison. An example of the computer-analyst exchange that produced these tables can be found in Davies (1978b).

Month	Reality	Unweighted Tension		1/f Weighted Tension	
		Indicator*	Outcome**	Indicator	Outcome
January	No Crisis	C	FA	NC	CR
February	No Crisis	C	FA	C	FA
March	No Crisis	NC	CR	NC	CR
April	No Crisis	C	FA	C	FA
May	Crisis	C	Hit	NC	Miss
June	Crisis	C	Hit	C	Hit
July	No Crisis	C	FA	NC	CR
August	No Crisis	NC	CR	NC	CR
September	No Crisis	C	FA	NC	CR
October	No Crisis	C	FA	NC	CR
November	No Crisis	C	FA	NC	CR
December	No Crisis	NC	CR	NC	CR

*C = Crisis
NC = No Crisis

**FA = False Alarm
CR = Correct Rejection

Table 4-20

ISRAEL-SYRIA, 1967
75 TENSION THRESHOLD

A comparison of Table 4-21a with 4-21b suggests that, in addition to increasing the overall percentage of successes, 1/f apparently acts to decrease the percentage of hits and false alarms and to increase the percentage of misses and correct rejections. However, the raw tension measure predicts nine crisis months and three no-crisis ones. while the 1/f measure predicts three crisis months and nine no crisis ones. To examine the effect of this difference, new cell percentages, based on the row totals, were computed. Tables 4-21c and 4-21d show these cell percentages for both measures. Although the overall percentage of successes for a given table does not change, the effect of the 1/f weight on the pattern within the table is quite different than that indicated in Tables 4-21a and 4-21b. When row totals are used, the percentage of hits increases by 11% rather than decreases. Similarly, the percentage of correct rejections does not increase but decreases from 100% to 89%. Although the direction of the change for false alarms and misses remains the same, the magnitude of the change differs. The summary findings from the Israeli-Syria case are that:

- given a prediction of crisis, the 1/f weighted tension measure is much more likely to result in a hit than is the unweighted measure; and
- given a prediction of no crisis, the 1/f measure is less likely to result in a correct rejection.

Comparison Across Twenty-five Historical Crises: Outcome percentages based on row totals rather than on total n size are designed to measure the performance of tension weights free from the influence of different numbers of crisis and no-crisis warnings.[37] So far the performance of

[37] The row percentages in these tables are equivalent to regressing the reality variable on the indicator signals where crisis = 1 and no crisis = 0. For example, the difference between % hit and % miss = b in the regression equation y = a+bx. More generally:

a = % miss
a+b = % hit

the 1/f tension measure has only been examined in one historical case and for one threshold level. Of primary importance is whether or not the 1/f tension measure has general effects not only across several tension levels but also across a number of crises. In order to examine this possibility, an analysis similar to the one just described for the Israeli-Syria case was carried out for twenty-five historical crises and for thresholds ranging in value from 70 to 90.[38] The tabular results of this analysis are given in Tables 4-22 to 4-26.

Several general effects of the 1/f tension measure should be noted. First, when the 1/f weight is applied to the raw tension scores, an average of sixty-three observations are moved from one cell to another for each threshold. The exact percentage reclassified correctly varies slightly across different threshold levels. For example, when a threshold value of 70 is used, the 1/f tension measure results in a movement of fifty-five cases, 86% of which are reclassified correctly. When a threshold value of 90 is used, 1/f results in a reclassification of seventy-two cases, with 76% put into the correct cells. On the average, 79% of all monthly observations are reclassified correctly. Thus, the 1/f tension measure is not only substantially affecting a large percentage of the total number of cases, but it is also greatly improving the overall percentage of successful predictions.[39]

Second, the effect of the 1/f weighted tension measure on the row percentages in each cell is consistently

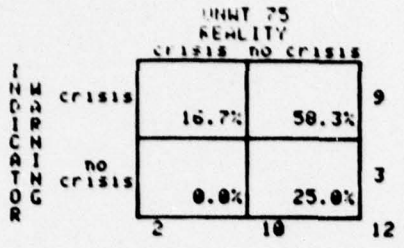
---

1-a = % corrent rejection
1-(a+b) = % false alarm

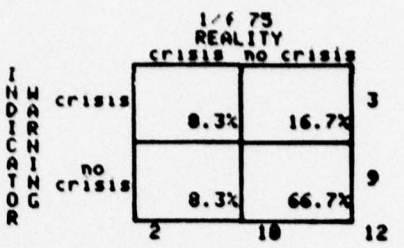
Also, the regression coefficients can be interpreted as probabilities of certain outcomes given indicator signals of crisis or no crisis. Thanks to Paul Rossa for pointing out this probability interpretation.

[38]For a complete listing of the file of all twenty-five crisis cases, see Daly and Bell (1977a).

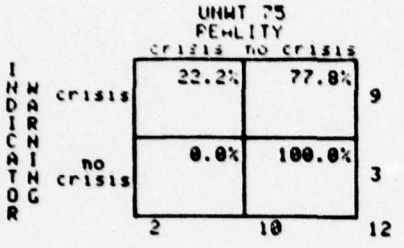
[39]This confirms the findings of Daly and Bell (1977a).



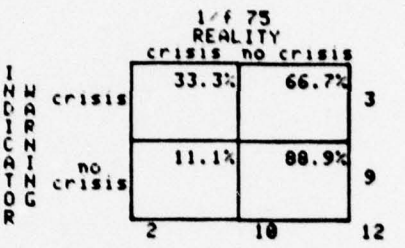
A. UNWEIGHTED TENSION
TOTAL PERCENTAGES



B. 1/f WEIGHTED TENSION
TOTAL PERCENTAGES



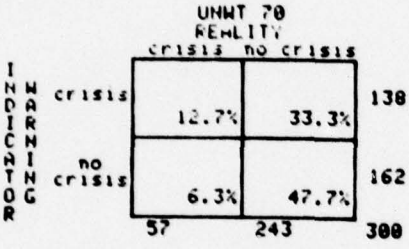
C. UNWEIGHTED TENSION
ROW PERCENTAGES



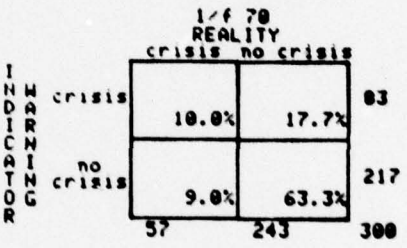
D. 1/f WEIGHTED TENSION
ROW PERCENTAGES

Table 4-21

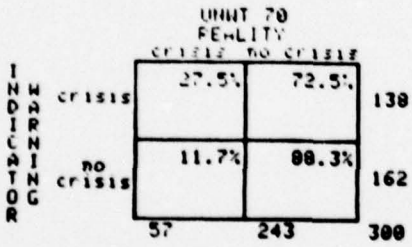
ISRAEL-SYRIA, 1967
75 THRESHOLD



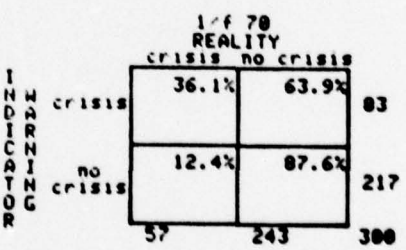
A. UNWEIGHTED TENSION
TOTAL PERCENTAGES



B. 1/f WEIGHTED TENSION
TOTAL PERCENTAGES



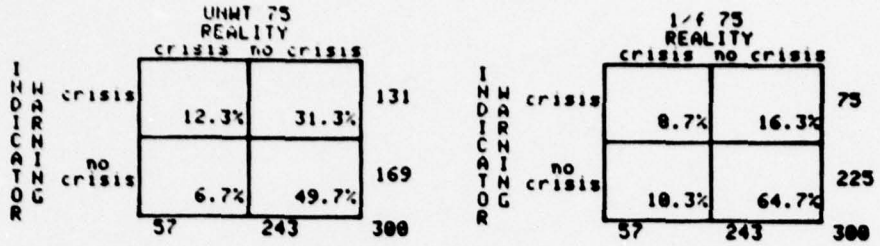
C. UNWEIGHTED TENSION
ROW PERCENTAGES



D. 1/f WEIGHTED TENSION
ROW PERCENTAGES

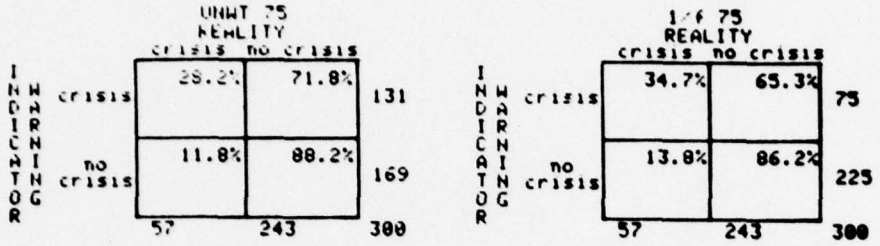
Table 4-22

25 HISTORICAL CRISES
70 THRESHOLD



A. UNWEIGHTED TENSION
TOTAL PERCENTAGES

B. 1/f WEIGHTED TENSION
TOTAL PERCENTAGES

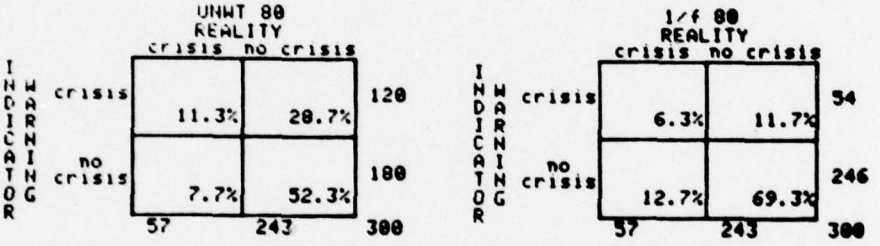


C. UNWEIGHTED TENSION
ROW PERCENTAGES

D. 1/f WEIGHTED TENSION
ROW PERCENTAGES

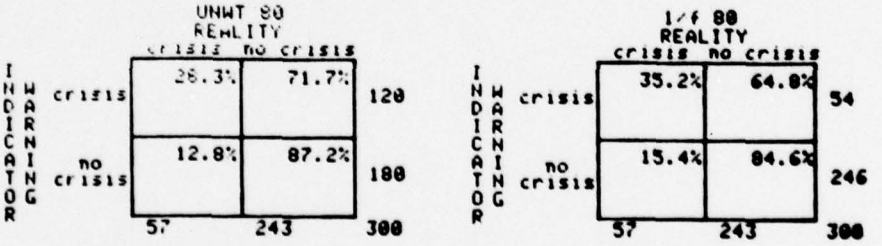
Table 4-23

25 HISTORICAL CRISES
75 THRESHOLD



A. UNWEIGHTED TENSION
TOTAL PERCENTAGES

B. 1/f WEIGHTED TENSION
TOTAL PERCENTAGES

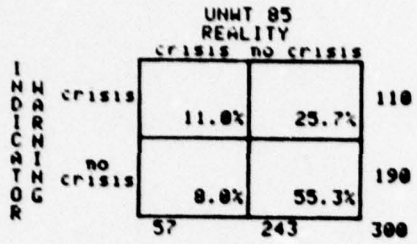


C. UNWEIGHTED TENSION
ROW PERCENTAGES

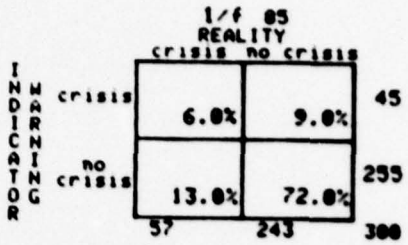
D. 1/f WEIGHTED TENSION
ROW PERCENTAGES

Table 4-24

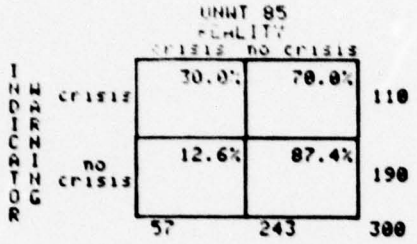
25 HISTORICAL CRISES
80 THRESHOLD



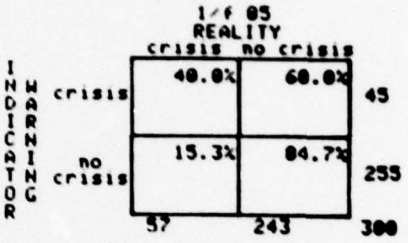
A. UNWEIGHTED TENSION
TOTAL PERCENTAGES



B. 1/f WEIGHTED TENSION
TOTAL PERCENTAGES



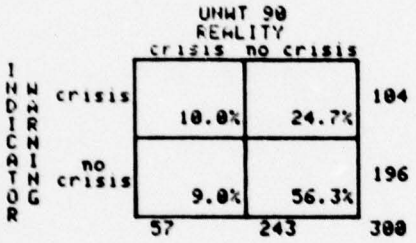
C. UNWEIGHTED TENSION
ROW PERCENTAGES



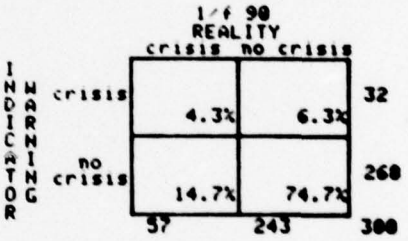
D. 1/f WEIGHTED TENSION
ROW PERCENTAGES

Table 4-25

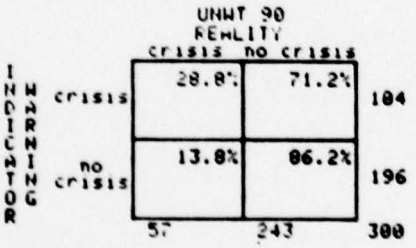
25 HISTORICAL CRISES
85 THRESHOLD



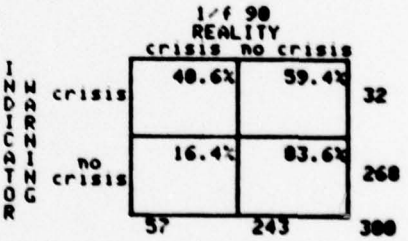
A. UNWEIGHTED TENSION
TOTAL PERCENTAGES



B. 1/f WEIGHTED TENSION
TOTAL PERCENTAGES



C. UNWEIGHTED TENSION
ROW PERCENTAGES



D. 1/f WEIGHTED TENSION
ROW PERCENTAGES

Table 4-26

25 HISTORICAL CRISES
90 THRESHOLD

the same across almost all crises and threshold levels. The 1/f tension measure always substantially increases the probability of a successful hit given a crisis prediction and, thus, always decreases the probability of a false alarm.[40] The 1/f tension measure also has an effect on misses and correct rejections. At every threshold level except 70, where there is no effect, the 1/f tension marginally increases the probability of misses and decreases the probability of correct rejections.

Third, overall the 1/f tension measure outperforms the unweighted measure. This is because the substantial increase in the probability of a hit that occurs when the 1/f weight is used, consistently offsets the small decrease in the probability of a correct rejection.

Investigations into the effects on cell frequencies of weighting the tension measure by 1/f have further substantiated the reasons for incorporating the measure into EWAMS. In comparison to the raw tension measure, the 1/f weighted tension algorithm always reduces the number of crisis predictions and increases the number of no-crisis predictions. Furthermore, differences in the number of crisis and no crisis predictions directly affect the probability of each type of outcome. When these differences are accounted for the 1/f weighted tension measure still provides the better fit with reality. Whether this finding continues to hold for other tension weights such as $1/f^2$ and 1/2f is now being tested.

The immediate advantage of using row percentages as a means of assessing the performance of an indicator is

[40] Note that this is not the case when percentages based on the total are examined because total percentages do not control for the decrease in the likelihood of predicting a crisis that resutls from the use of a 1/f weighted tension measure.

that no assumptions are made about user preferences for outcomes of certain types. This is in contrast to measures of indicator-reality associations, such as Yule's Q, which weight each of the four outcomes in the table equally. Measures of association like Yule's Q implicitly assume that in choosing an indicator for warning, an error due to a false alarm is just as bad as an error that results from a miss. Or, that a hit outcome is just as desirable as a correct rejection. However, users do not have equal preferences across all outcome types. By calculating row percentages, a measure of performance is obtained that does not constrain the analyst to equal preferences for hits, misses, false alarms, and correct rejections. Additionally, row percentages have a direct substantive interpretation and can easily be transformed into probabilities.

We are currently exploring ways in which user preferences for various outcomes can be integrated into the process of selecting both tension weights and thresholds. One approach under consideration is the use of a decision model that would combine probabilities with user preferences for hit, miss, false alarm and correct rejection outcomes. This would allow the analyst to reassess the performance of different tension measures depending on his preferences for each type of outcome.

4.2.2 Warning and forecasting capability. As suggested with varying degrees of explicitness throughout this report, warning--not merely information retrieval or monitoring--is the ultimate objective of the EWAMS project. Indicator thresholds, such as those discussed above for the tension measure, and probabilities are the key to warning in the current version of EWAMS.

Probabilities:[41] The "global" probabilities now generated by EWAMS differ from those initially used[42] in the following ways:

- They are based on twenty-seven historical crises rather than four.
- The probabilities of crisis for total, conflictual and cooperative activity are independent rather than those for total and conflict being identical for the same z-score ranges.
- The interactive program which generates probabilities allows the analyst flexibility in terms of number and selection of crisis cases, ranges of z-scores to be examined, and assignment of probabilities.

In its current state, the probability program[43] will add considerable validity and flexibility to on-going research and testing. The objectives of the probability generation task have been fulfilled in at least a preliminary fashion: the demonstration system now yields more valid and reliable tables, research and testing have been facilitated, and the groundwork has been laid for a sophisticated option which will enhance user input and expertise.

"Global" P-tables are, of course, no such thing. They are based on international crises between 1966-75 for which we had adequate data; that is, African and Latin American crises are excluded. Inclusion of crises from these regions would have been detrimental to hit and false alarm rate calculations. The twenty-seven crises on which the P-tables are based are listed in Table 4-27.

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[41] This section borrows liberally from Daly and Bell (1977b).

[42] For examples of "old" probabilities see Andriole (1976a) and International Public Policy Research Corporation (1978).

[43] In this context, "standalone" means that the program is separate from the master crisis software; it does not mean that the program is independent of a host computer.

1	2	3	4	5	6	7
jor	syr	6601	6612	6611	6612	6612
jor	plo	6601	6612	6611	6612	6612
jor	isr	6701	6712	6705	6706	6706
jor	isr	6709	6808	6712	6801	6803
jor	syr	7001	7012	7008	7009	7009
jor	plo	7001	7012	7008	7009	7009
usr	chn	6608	6707	6612	6701	6702
usr	cze	6801	6812	6807	6808	6808
usr	chn	6901	6912	6902	6903	6903
usr	usa	7001	7012	7008	7009	7009
usr	usa	7301	7312	7309	7310	7310
isr	syr	6701	6712	6705	6706	6706
isr	uar	6701	6712	6705	6706	6706
isr	uar	6901	6912	6901	6902	6903
isr	syr	6901	6912	6901	6902	6903
isr	syr	7001	7012	7008	7009	7009
isr	uar	7301	7312	7309	7310	7310
isr	syr	7301	7312	7309	7310	7310
grc	tur	6701	6712	6710	6711	6711
grc	tur	7401	7412	7406	7407	7407
tur	cyp	6701	6712	6710	6711	6711
tur	cyp	7401	7412	7406	7407	7407
usa	kon	6708	6807	6712	6801	6802
usa	syr	7001	7012	7008	7009	7009
ind	pak	7106	7205	7110	7111	7112

Format:

1. Initiator
2. Recipient
3. Beginning yr. of crisis - Date
4. End of crisis year - Date
5. Pre-crisis month - Date
6. Beginning month of crisis - Date
7. Last month of crisis - Date

Table 4-27

FILE OF ALL CRISIS CASES

The old probabilities were based on visual and manual analysis of the Czech, India-Pakistan, and Sino-Soviet (1967 and 1969) crises. The probabilities resulting from this analysis and their concommitant z-scores are given in Table 4-28. Table 4-29 presents the z-scores and probabilities generated from the sample of twenty-seven crises. A comparison of the total activity probabilities indicates that the highest probability of crisis for total activity can be signalled with a lower z-score when one bases the calculations on a greater number of crises. This should provide somewhat greater warning time and raise the hit rate of the probabilities.[44]

With the old probabilities, those for total and conflict activity were identical for the same z-score ranges. For the new ones, the conflict probabilities were generated independently. It is to be noted that the conflict probabilities decrease more slowly than the total activity probabilities. While aware of McClelland's view that total activity is *most important*, we feel that in light of the needs of prospective users of the system, conflict activity should be given slightly greater weight vis-a-vis the other two indicators.

Based on the historical, empirical reality of twenty-seven crises, probabilities of crisis based on cooperative activity can only provide warning in the upper registers. This does, however, coincide with the logic behind McClelland's use of Hrel (McClelland et al. 1971 and McClelland 1972).

A better feel may perhaps be obtained for the differences in the old and new probabilities by looking at some case studies using exactly the same events data and

[44]These propositions require extensive testing in both retrospective and "real-time" modes.

TOTAL ACTIVITY

Z	Crisis	Non-Crisis	Total
+18–∞	90%	10%	100%
+10–18	80%	20%	100%
+6–10	70%	30%	100%
+4–6	60%	40%	100%
+3–4	50%	50%	100%
+2–3	40%	60%	100%
+1–2	10%	90%	100%
0–+1	5%	95%	100%
0	1%	99%	100%

CONFLICTUAL ACTIVITY

Z	Crisis	Non-Crisis	Total
+18	90%	10%	100%
+10–18	80%	20%	100%
+6–10	70%	30%	100%
+4–6	60%	40%	100%
+3–4	50%	50%	100%
+2–3	40%	60%	100%
+1–2	10%	90%	100%
0–+1	5%	95%	100%
0	1%	99%	100%

COOPERATIVE ACTIVITY

Z	Crisis	Non-Crisis	Total
+18–∞	70%	30%	100%
+10–18	60%	40%	100%
+6–10	40%	60%	100%
+4–6	20%	80%	100%
+3–4	10%	90%	100%
+2–3	5%	95%	100%
+1–2	1%	99%	100%
0–+1	0%	100%	100%
0		100%	100%

Table 4-28

OLD PROBABILITIES

TOTAL ACTIVITY

Z	Crisis	Non-Crisis	Total
+16–∞	95%	5%	100%
+11–16	80%	20%	100%
+6–11	56%	44%	100%
+2–6	40%	60%	100%
+1–2	16%	84%	100%
+0–1	13%	87%	100%
-∞–0	10%	90%	100%

CONFLICTUAL ACTIVITY

Z	Crisis	Non-Crisis	Total
+16–∞	98%	2%	100%
+11–16	80%	20%	100%
+8–11	75%	25%	100%
+5–8	65%	35%	100%
+2–5	48%	52%	100%
+1–2	23%	77%	100%
+0–1	18%	82%	100%
-∞–0	10%	90%	100%

COOPERATIVE ACTIVITY

Z	Crisis	Non-Crisis	Total
+16–∞	95%	5%	100%
+4–16	41%	59%	100%
+1–4	21%	79%	100%
+0–1	15%	85%	100%
-∞–0	10%	90%	100%

Table 4-29

GLOBAL PROBABILITIES

indicators. Tables 4-30 and 4-31 present the indicators for the old and global probabilities for the Czech invasion. The old total activity indicators seem to provide more warning than the new total activity ones. However, an examination reveals that: 1) the old total probabilities of .50 and .70 for February and March 1968 are based only on cooperative events--there were no conflictual ones; and 2) the global conflict probabilities provide slightly better warning of the crisis and are definitely better at recording the aftershock of the invasion.

As indicated by Tables 4-32 and 4-33, the major difference between the old and global probabilities for the India-Pakistani crisis is the higher old probability of .70 (versus the global one of .56) in November, the first month of the war. However, the global conflict probabilities, which we are emphasizing, perform much better than the old ones in that they do not drop off as precipitously after the initial peak in April as do the old ones. The decline to .01 for three consecutive months in the old probabilities might have led an analyst to believe that the trouble had passed and a crisis been averted. The global probabilities, being higher and more dynamic, would have been less likely to result in such an analysis.

Both the old and new probabilities provided excellent warning of the June 1967 Middle East War (Tables 4-34 and 4-35). However, both sets failed rather dismally in forecasting the October war (Tables 4-36 and 4-37). The global probabilities were much better at registering the aftershocks of the conflict. The inadequate performance of the indicators in providing warning of the October War suggests the need for generating regional probability tables.

MONTHLY ACTIVITY
JAN. 1968 - DEC. 1968

CZE <<<<<< TWO-WAY FLOW >>>>>> USP

DATE	TOTAL ACTIVITY NUMBER	TOTAL ACTIVITY Z-SCORE	TOTAL ACTIVITY PROB	COOPERATIVE ACTIVITY NUMBER	COOPERATIVE ACTIVITY Z-SCORE	COOPERATIVE ACTIVITY PROB	CONFLICTUAL ACTIVITY NUMBER	CONFLICTUAL ACTIVITY Z-SCORE	CONFLICTUAL ACTIVITY PROB
JAN 68	1	1.95	.10	1	1.95	.01	0	0.00	.01
FEB 68	2	3.89	.50	2	3.89	.10	0	0.00	.01
MAR 68	5	8.12	.70	5	8.12	.40	0	0.00	.01
APR 68	8	7.01	.70	4	3.32	.05	4	0.00	.01
MAY 68	21	11.38	.80	12	9.09	.40	9	11.72	.80
JUN 68	12	2.55	.40	8	2.87	.05	4	1.97	.10
JUL 68	37	7.79	.70	13	4.31	.10	24	12.41	.80
AUG 68	48	5.83	.60	20	5.37	.20	28	5.80	.60
SEP 68	41	3.33	.40	28	5.51	.20	13	1.66	.10
OCT 68	21	1.24	.05	16	2.03	.01	5	.38	.01
NOV 68	11	.41	.01	4	.10	.01	7	.67	.05
DEC 68	10	.32	.01	8	.71	.01	2	-.10	.01

Table 4-30

SOVIET UNION ⟷ CZECHOSLOVAKIA
TWO-WAY MONTHLY ACTIVITY LEVELS
JANUARY – DECEMBER, 1968

Monthly Activity
Jan. 1968 - Dec. 1968

USR <<<<<< Two-Way Flow >>>>>> CZE

Date	Total Activity number	Total Activity z-score	Total Activity prob	Cooperative Activity number	Cooperative Activity z-score	Cooperative Activity prob	Conflictual Activity number	Conflictual Activity z-score	Conflictual Activity prob
Jan 68	1	1.95	0.16	1	1.95	0.21	0	0.00	0.10
Feb 68	2	3.89	0.40	2	3.89	0.21	0	0.00	0.10
Mar 68	5	8.12	0.56	5	8.12	0.41	0	0.00	0.10
Apr 68	8	7.01	0.56	4	3.32	0.21	4	0.00	0.10
May 68	21	11.38	0.80	12	9.09	0.41	9	11.72	0.80
Jun 68	12	2.55	0.40	8	2.87	0.21	4	1.97	0.23
Jul 68	37	7.79	0.56	13	4.31	0.41	24	12.41	0.80
Aug 68	48	5.83	0.40	20	5.37	0.41	28	5.80	0.63
Sep 68	41	3.33	0.40	28	5.51	0.41	13	1.66	0.23
Oct 68	21	1.24	0.16	16	2.03	0.21	5	0.38	0.18
Nov 68	11	0.41	0.13	4	0.10	0.15	7	0.67	0.18
Dec 68	10	0.32	0.13	8	0.71	0.15	2	-0.10	0.10

Table 4-31

SOVIET UNION ⟷ CZECHOSLOVAKIA
TWO-WAY MONTHLY ACTIVITY LEVELS
JANUARY – DECEMBER, 1968

MONTHLY ACTIVITY
FEB, 1971 - JAN, 1972

IND <<<<<< TWO-WAY FLOW >>>>>> PAK

DATE	TOTAL ACTIVITY NUMBER	Z-SCORE	PROB	COOPERATIVE ACTIVITY NUMBER	Z-SCORE	PROB	CONFLICTUAL ACTIVITY NUMBER	Z-SCORE	PROB
FEB 71	6	1.53	.10	0	-.37	.01	6	3.52	.50
MAR 71	4	.79	.05	0	-.37	.01	4	1.94	.10
APR 71	48	16.19	.80	3	.90	.01	45	26.67	.90
MAY 71	19	2.57	.40	2	.47	.01	17	2.68	.40
JUN 71	0	-.41	.01	0	-.39	.01	0	-.30	.01
JUL 71	3	.05	.01	6	-.38	.01	3	.20	.01
AUG 71	2	-.11	.01	0	-.38	.01	2	.03	.01
SEP 71	7	.66	.05	2	.49	.01	5	.54	.05
OCT 71	22	2.94	.40	1	.05	.01	21	3.27	.40
NOV 71	60	8.28	.70	5	1.01	.01	55	8.46	.70
DEC 71	218	22.28	.90	20	8.25	.40	198	22.12	.90
JAN 72	10	.12	.01	7	1.00	.01	3	-.11	.01

Table 4-32

INDIA ⟷ PAKISTAN
TWO-WAY MONTHLY ACTIVITY LEVELS
FEBRUARY, 1971 – JANUARY, 1972

Monthly Activity
Feb, 1971 - Jan, 1972

ind <<<<<< Two-Way Flow >>>>>> pak

Date	Total Activity number	z-score	prob	Cooperative Activity number	z-score	prob	Conflictual Activity number	z-score	prob
Feb 71	6	1.53	0.16	0	-0.37	0.10	6	3.52	0.48
Mar 71	4	0.79	0.13	0	-0.37	0.10	4	1.94	0.23
Apr 71	48	16.19	0.95	3	0.90	0.15	45	26.67	0.98
May 71	19	2.57	0.40	2	0.47	0.15	17	2.68	0.48
Jun 71	0	-0.41	0.10	0	-0.39	0.10	0	-0.30	0.10
Jul 71	3	0.05	0.13	0	-0.38	0.10	3	0.20	0.18
Aug 71	2	-0.11	0.10	0	-0.38	0.10	2	0.03	0.18
Sep 71	7	0.66	0.13	2	0.49	0.15	5	0.54	0.18
Oct 71	22	2.94	0.40	1	0.05	0.15	21	3.27	0.48
Nov 71	60	8.28	0.56	5	1.81	0.21	55	8.46	0.75
Dec 71	218	22.28	0.95	20	8.25	0.41	198	22.12	0.98
Jan 72	10	0.12	0.13	7	1.80	0.21	3	-0.11	0.10

Table 4-33

INDIA ⟷ PAKISTAN
TWO-WAY MONTHLY ACTIVITY LEVELS
FEBRUARY, 1971 – JANUARY, 1972

MONTHLY ACTIVITY
JAN. 1967 - DEC. 1967

*** ISR <<<<<< TWO-WAY FLOW >>>>>> SYR ***

DATE	TOTAL ACTIVITY NUMBER	Z-SCORE	PROB	COOPERATIVE ACTIVITY NUMBER	Z-SCORE	PROB	CONFLICTUAL ACTIVITY NUMBER	Z-SCORE	PROB
JAN 67	27	4.44	.50	6	6.02	.20	21	3.95	.50
FEB 67	5	-.14	.01	0	-.58	.01	5	-.01	.01
MAR 67	0	-.78	.01	0	-.55	.01	0	-.03	.01
APR 67	10	.58	.05	0	-.53	.01	10	.07	.05
MAY 67	2	-.53	.01	0	-.51	.01	2	-.51	.01
JUN 67	26	2.83	.40	5	2.71	.05	21	2.76	.40
JUL 67	8	.14	.01	2	.55	.01	6	.03	.01
AUG 67	0	-.83	.01	0	-.59	.01	0	-.87	.01
SEP 67	1	-.67	.01	0	-.57	.01	1	-.68	.01
OCT 67	1	-.65	.01	0	-.55	.01	1	-.66	.01
NOV 67	3	-.38	.01	0	-.54	.01	3	-.33	.01
DEC 67	0	-.76	.01	0	-.52	.01	0	-.80	.01

Table 4-34

ISRAEL ↔ SYRIA
TWO-WAY MONTHLY ACTIVITY LEVELS
JANUARY, 1967 – DECEMBER, 1967

Monthly Activity
Jan, 1967 - Dec, 1967

*** isr <<<<<< Two-Way Flow >>>>>> usr ***

Date	Total Activity number	z-score	prob	Cooperative Activity number	z-score	prob	Conflictual Activity number	z-score	prob
Jan 67	0	-0.87	0.10	0	-0.29	0.10	0	-0.74	0.10
Feb 67	0	-0.81	0.10	0	-0.28	0.10	0	-0.69	0.10
Mar 67	0	-0.76	0.10	0	-0.27	0.10	0	-0.66	0.10
Apr 67	0	-0.72	0.10	0	-0.26	0.10	0	-0.63	0.10
May 67	13	15.28	0.80	1	1.75	0.21	12	15.89	0.80
Jun 67	18	5.36	0.40	4	7.23	0.41	14	4.46	0.40
Jul 67	39	7.41	0.56	3	2.52	0.21	36	8.27	0.75
Aug 67	5	0.09	0.13	4	2.96	0.21	1	-0.30	0.10
Sep 67	18	1.46	0.16	0	-0.51	0.10	18	1.69	0.23
Oct 67	10	0.53	0.13	0	-0.49	0.10	10	0.65	0.18
Nov 67	5	-0.01	0.10	1	0.27	0.15	4	-0.05	0.10
Dec 67	2	-0.33	0.10	0	-0.50	0.10	2	-0.28	0.10

Table 4-35

ISRAEL ↔ SYRIA
TWO-WAY MONTHLY ACTIVITY LEVELS
JANUARY, 1967 – DECEMBER, 1967

MONTHLY ACTIVITY
JAN, 1973 - DEC, 1973

*** ISR <<<<<< TWO-WAY FLOW >>>>>> UAR ***

DATE	TOTAL ACTIVITY NUMBER	Z-SCORE	PROB	COOPERATIVE ACTIVITY NUMBER	Z-SCORE	PROB	CONFLICTUAL ACTIVITY NUMBER	Z-SCORE	PROB
JAN 73	0	-.89	.01	0	-.63	.01	0	-.82	.01
FEB 73	9	-.29	.01	1	-.05	.01	8	-.29	.01
MAR 73	3	-.68	.01	0	-.63	.01	3	-.62	.01
APR 73	0	-.88	.01	0	-.63	.01	0	-.81	.01
MAY 73	4	-.60	.01	1	-.04	.01	3	-.60	.01
JUN 73	8	-.33	.01	2	.55	.01	6	-.40	.01
JUL 73	1	-.80	.01	0	-.63	.01	1	-.73	.01
AUG 73	9	-.26	.01	3	1.14	.01	6	-.39	.01
SEP 73	2	-.72	.01	1	-.05	.01	1	-.72	.01
OCT 73	184	11.55	.80	37	21.23	.70	147	9.18	.70
NOV 73	73	2.54	.40	37	8.73	.40	36	1.13	.05
DEC 73	74	2.49	.10	19	3.15	.05	55	2.06	.10

Table 4-36

ISRAEL ◄► EGYPT
TWO-WAY MONTHLY ACTIVITY LEVELS
JANUARY, 1973 – DECEMBER, 1973

Monthly Activity
Jan, 1973 - Dec, 1973

*** isr <<<<<< Two-Way Flow >>>>>> uar ***

Date	Total Activity number	z-score	prob	Cooperative Activity number	z-score	prob	Conflictual Activity number	z-score	prob
Jan 73	0	-0.89	0.10	0	-0.63	0.10	0	-0.82	0.10
Feb 73	9	-0.29	0.10	1	-0.05	0.10	8	-0.29	0.10
Mar 73	3	-0.68	0.10	0	-0.63	0.10	3	-0.62	0.10
Apr 73	0	-0.88	0.10	0	-0.63	0.10	0	-0.81	0.10
May 73	4	-0.60	0.10	1	-0.04	0.10	3	-0.60	0.10
Jun 73	8	-0.33	0.10	2	0.55	0.15	6	-0.40	0.10
Jul 73	1	-0.80	0.10	0	-0.63	0.10	1	-0.73	0.10
Aug 73	9	-0.26	0.10	3	1.14	0.21	6	-0.39	0.10
Sep 73	2	-0.72	0.10	1	-0.05	0.10	1	-0.72	0.10
Oct 73	184	11.55	0.80	37	21.23	0.95	147	9.18	0.75
Nov 73	73	2.54	0.40	37	8.73	0.41	36	1.13	0.23
Dec 73	74	2.49	0.40	19	3.15	0.21	55	2.06	0.48

Table 4-37

ISRAEL ◄► EGYPT
TWO-WAY MONTHLY ACTIVITY LEVELS
JANUARY, 1973 – DECEMBER, 1973

Development of Global P-Tables: Our initial intention to generate probabilities for crisis, non-crisis, and pre-crisis periods was rendered impossible by the lack of observations in the pre-crisis (the month preceeding the crisis month) category. The pre-crisis period was therefore merged with the crisis month to generate the probabilities. Although this is a less desirable method than having a separate pre-crisis category, it is argued that when one is generating probabilities from historical data to be eventually used on "real-time" data, the prediction implied by probabilities should be based on as much information as possible. When historical pre-crisis periods do not contain enough data to generate probabilities, pragmatism requires a hedging of both historical reality and theory. The merging of pre-crisis and crisis periods has obvious implications for hit and false alarm rates. Logically, the method should raise false alarm rates; given our data, it may increase hit rates. In either case, when a real-world crisis does occur, the warning time should be greater.[45] Based on our conversations with potential users of the system, analysts at their level are quite willing to trade false alarms for increased warning time.

After it was decided to merge the crisis and pre-crisis categories, frequencies of z-scores (by intervals of one) in crisis and non-crisis were generated as were row percents. Tables 4-38 and 4-39 illustrate this process for conflict activity. The Tables show that there are several intervals with no z-scores occurring for the twenty-seven crises; this also holds for total and cooperative activity. The z-scores were therefore grouped so that the crisis percentages would decrease with the z-scores. The final intervals and associated probabilities are given in Tables 4-40, 4-41, and 4-42.

[45] The propositions will, of course, be thoroughly explored.

z-score frequencies

z-score	crisis	non-cris	total
+ 20- 99	6	0	6
+ 19- 20	0	0	0
+ 18- 19	0	0	0
+ 17- 18	0	0	0
+ 16- 17	0	0	0
+ 15- 16	2	0	2
+ 14- 15	0	0	0
+ 13- 14	0	0	0
+ 12- 13	1	0	1
+ 11- 12	1	2	3
+ 10- 11	0	1	1
+ 9- 10	1	0	1
+ 8- 9	2	1	3
+ 7- 8	1	0	1
+ 6- 7	0	1	1
+ 5- 6	4	3	7
+ 4- 5	4	2	6
+ 3- 4	2	4	6
+ 2- 3	5	8	13
+ 1- 2	6	24	30
+ 0- 1	10	52	62
+-99- 0	16	165	181

Table 4-38

CONFLICT Z-SCORES FOR 27 CRISES
BY INTERVALS OF 1

z-score	crisis	non-cris	total
+ 20- 99	1.00	0.00	1.00
+ 19- 20	0.00	0.00	0.00
+ 18- 19	0.00	0.00	0.00
+ 17- 18	0.00	0.00	0.00
+ 16- 17	0.00	0.00	0.00
+ 15- 16	1.00	0.00	1.00
+ 14- 15	0.00	0.00	0.00
+ 13- 14	0.00	0.00	0.00
+ 12- 13	1.00	0.00	1.00
+ 11- 12	0.33	0.67	1.00
+ 10- 11	0.00	1.00	1.00
+ 9- 10	1.00	0.00	1.00
+ 8- 9	0.67	0.33	1.00
+ 7- 8	1.00	0.00	1.00
+ 6- 7	0.00	1.00	1.00
+ 5- 6	0.57	0.43	1.00
+ 4- 5	0.67	0.33	1.00
+ 3- 4	0.33	0.67	1.00
+ 2- 3	0.38	0.62	1.00
+ 1- 2	0.20	0.80	1.00
+ 0- 1	0.16	0.84	1.00
+-99- 0	0.09	0.91	1.00

Table 4-39

CONFLICT Z-SCORES, PERCENTS FOR 27 CRISES
BY INTERVALS OF 1

total activity - two way flows

z-score frequencies

z-score	crisis	non-cris	total
+ 16- 99	5	0	5
+ 11- 16	4	2	6
+ 6- 11	7	7	14
+ 2- 6	14	23	37
+ 1- 2	4	26	30
+ 0- 1	8	63	71
+-99- 0	19	142	161

probabilities

z-score	crisis	non-cris	total
+ 16- 99	1.00	0.00	1.00
+ 11- 16	0.67	0.33	1.00
+ 6- 11	0.50	0.50	1.00
+ 2- 6	0.38	0.62	1.00
+ 1- 2	0.13	0.87	1.00
+ 0- 1	0.11	0.89	1.00
+-99- 0	0.12	0.88	1.00

corrected probs - total activity

z-score	prob	freq	1/f	1/2f	1/f*2	1/f+1*
+ 16- 99	1.00	5	1.20	1.10	1.04	.95
+ 11- 16	0.67	4	0.83	0.75	0.71	0.80
+ 6- 11	0.50	7	0.57	0.54	0.51	0.56
+ 2- 6	0.38	14	0.41	0.39	0.38	0.40
+ 1- 2	0.13	4	0.17	0.15	0.14	0.16
+ 0- 1	0.11	8	0.13	0.12	0.11	0.13
+-99- 0	0.12	19	0.12	0.12	0.12	.10

* Weight used

Table 4-40

FINAL INTERVALS, TOTAL ACTIVITY,
PROBABILITIES, AND WEIGHTING FACTORS

conflictual activity - two way flows

z-score frequencies

z-score	crisis	non-cris	total
+ 16- 99	6	0	6
+ 11- 16	4	2	6
+ 8- 11	3	2	5
+ 5- 8	5	4	9
+ 2- 5	11	14	25
+ 1- 2	6	24	30
+ 0- 1	10	52	62
+-99- 0	16	165	181

probabilities

z-score	crisis	non-cris	total
+ 16- 99	1.00	0.00	1.00
+ 11- 16	0.67	0.33	1.00
+ 8- 11	0.60	0.40	1.00
+ 5- 8	0.56	0.44	1.00
+ 2- 5	0.44	0.56	1.00
+ 1- 2	0.20	0.80	1.00
+ 0- 1	0.16	0.84	1.00
+-99- 0	0.09	0.91	1.00

corrected probs - conflictual activity

z-score	prob	freq	1/f	1/2f	1/f*2	1/f+1*
+ 16- 99	1.00	6	1.17	1.08	1.03	.98
+ 11- 16	0.67	4	0.83	0.75	0.71	.80
+ 8- 11	0.60	3	0.80	0.70	0.67	.75
+ 5- 8	0.56	5	0.67	0.61	0.58	.65
+ 2- 5	0.44	11	0.48	0.46	0.44	.48
+ 1- 2	0.20	6	0.23	0.22	0.21	.23
+ 0- 1	0.16	10	0.18	0.17	0.16	.18
+-99- 0	0.09	16	0.09	0.09	0.09	.10

* Weight used

Table 4-41

FINAL INTERVALS, CONFLICTUAL ACTIVITY, PROBABILITIES, AND WEIGHTING FACTORS

cooperative activity - two way flows

z-score frequencies

z-score	crisis	non-cris	total
+ 16- 99	5	0	5
+ 4- 16	11	18	29
+ 1- 4	9	39	48
+ 0- 1	5	33	38
+-99- 0	31	173	204

probabilities

z-score	crisis	non-cris	total
+ 16- 99	1.00	0.00	1.00
+ 4- 16	0.38	0.62	1.00
+ 1- 4	0.19	0.81	1.00
+ 0- 1	0.13	0.87	1.00
+-99- 0	0.15	0.85	1.00

corrected probs - cooperative activity

z-score	prob	freq	1/f	1/2f	1/f*2	1/f+1 *
+ 16- 99	1.00	5	1.20	1.10	1.04	.95
+ 4- 16	0.38	11	0.41	0.40	0.38	.41
+ 1- 4	0.19	9	0.21	0.20	0.19	.21
+ 0- 1	0.13	5	0.16	0.14	0.14	.15
+-99- 0	0.15	31	0.16	0.15	0.15	.10

* Weight used

Table 4-42

FINAL INTERVALS, COOPERATIVE ACTIVITY, PROBABILITIES, AND WEIGHTING FACTORS

The final step in generating global P-tables was to experiment with different weighting factors. The rationale for weighting was dual: (1) cosmetic--to enhance the appearance of the probabilities in terms of dynamism and distance, and therefore increase appeal to potential users; and (2) theoretical--to increase the impact of probabilities based on "extreme" z-scores. In line with this, all the weighting factors tested had the effect of increasing probabilities, with the greatest effect being on high z-scores and the least effect on low ones. The various weighting factors and their results appear in Tables 4-40, 4-41, and 4-42.[46]

Selection of the final weight for each indicator was, again, based on cosmetics and theory. These probabilities are hard-wired into the master version of EWAMS.[47]

A comparison of the final probabilities for total, conflictual, and cooperative activity reveals two arbitrary decisions. First, the empirically founded probability of 1.00 for all three indicators in the highest interval was reduced to .98 for conflict and .95 for total and cooperative. Despite our confidence in the early warning system as a whole, given inadequacies in data which sometimes necessitated a brute force methodology for probabilities, we feel that forecasting a crisis with a 1.00 probability would be somewhat audacious. Second, all probabilities in the -99 - 0 range were changed to .10.

Future Development: Development and testing of probability tables will continue. Our intention is to

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[46]The general algorithm for weighting can be illustrated with the 1/f weight. It is calculated:

probability + probability/frequency.

[47]However, with the interactive standalone version of P-tables, the analyst can select other weights, no weights, create his own, and apply them to any crisis of his choice.

enhance flexibility, increase the number of user options, advance testing and integrate future improvements into the master version of EWAMS. Possible developments along these lines might include giving the user the option of tails of varying lengths; different types of graphical presentation of probabilities, such as log odds and bar charts; and menus oriented toward both the novice and expert.

There are many aspects of EWAMS that still require exploration and testing. Several of these are related to P-tables. Hit and false alarm rates for the indicators per se and for probabilities must be examined. This will require interaction with potential users and designation of thresholds addressed to their needs.

Different tails for the indicator z-scores must be tested before integration into the demonstration system. That is, rather than calculating z-scores progressively since 1966, the results of using only 30-, 60-, or 90-day tails must be analyzed. Related to this, the performance of normal z-scores in warning of crises must be tested and probabilities generated from them compared with those based on progressive z-scores. Probabilities calculated with Bayes' Theorem must also be tested and compared.

As mentioned above, regional P-tables, at least for the Middle East, must be generated and their performance compared with the "global" tables. Probability conversion tables for nations with similar structural characteristics, similar behavioral characteristics, specific dyads, one-way flows for all indicators, and for initiators and recipients must be examined and compared for effectiveness of early warning.[48] Generation of probabilities for the other international political indicators currently in the system should also be explored as must probabilities for the military and

[48] See Andriole (1977a) for elaboration of these notions.

economic indicators to be integrated into the prototype system. The flexibility of the interactive P-tables program will facilitate testing in all these areas.

The program will also be a useful tool for carrying out research for the blend of subjective and objective methodologies. The analyst can observe the quantitative indicators and their probabilities, evaluate them in terms of his own expertise, modify them and then compare them retrospectively and, eventually, in a real-time mode.

Finally, in terms of development, the variants of the probability conversion tables will be dynamic. This dynamism stems not only from the capability to input analyst-generated probabilities (subjective and/or objective), but from periodical updates. Global P-tables are presently based on twenty-seven crises which occurred between 1966-75. This will shortly be updated by adding crises occurring since 1975 and by basing P-tables on the most reliable version of WEIS. It must be determined if the few frequency differences between that data and the data used to generate global P-tables will affect them. As the number of crises on which P-tables are based grows, our inferences from past to future crisis occurrence will increase in reliability and validity.[49]

4.2.3 Problems and issues revealed by testing. In a preliminary attempt to remedy long-standing neglect of the evaluation and thresholding components of the monitoring process, and to address the myriad questions raised in the preceding sections, this section focuses on problems and issues associated with evaluation and thresholding for monitoring and warning. The purpose of the section is to raise questions for future research, not to provide answers.

[49] For elaboration on this statement see McClelland (1969).

Nor is there any attempt to address all the problems; only those that are immediately apparent from: (1) application of the Early Warning and Monitoring System to many historical cases and (2) interaction with I&W analysts, will be discussed.

In our research with a prototypical computer-based monitoring and warning system, we have learned that there are many specific problems and issues not treated by general conceptual discussions. These include: differentiating signals from noise, differentiating exercises from crises, information retrieval vs. monitoring, relating thresholds to warning purposes, relating warning/monitoring to action/decision, and clarifying the purposes of warning.

A preliminary, non-comprehensive list of problems and issues revealed by our research as well as interaction with potential users is as follows:

Monitoring

- Targets of Monitoring
  - What/who should be tracked?
- Evaluation/Interpretation
  - How can signals be separated from noise?
  - How should context be interpreted?
  - Are diverse indicators tracking different phenomena?
  - How are the indicators related?
  - How should different signals be weighted?
  - How should conflicting signals be integrated?

Warning

- Timing
  - When, how often should a warning be given?
- Generalization
  - How much pattern recurrence is required for warning?

- Thresholds
  - What are the costs and benefits to analysts of different thresholds?
  - What are analyst preferences for false alarms vs. misses?
  - Must thresholds be country-, region-, dyad-specific?

- Theory
  - Is theoretical knowledge useful for warning or vice versa?

- A multitude of problems associated with "crisis," and exercises, e.g.:
  - What definition(s) should be used?
  - How many types of crises are there and what are the patterns associated with each?
  - Is it possible to provide warning of all types of crises?
  - How can exercises be differentiated from mobilizations?

Targets of Monitoring: The not-so-easy answer to what or who should be tracked is--any country that might be potentially involved in a crisis or conflict. Analysis of the 1967 Middle East War (Daly 1978) suggests that an analyst tracking just the U.S. and Soviets with the Early Warning and Monitoring System in May 1967 might have been able to forecast the June War in the Middle East. Of course, the number of possible networks which might be monitored is virtually limitless, which may partly explain the reluctance of real-world analysts to consider the activities of countries outside their area of responsibility, even when these activities may have a great impact on their region of concern.

A possible solution to the targeting problem would be an automatic scan of potential conflict networks. For example, if conflict or tension indicators for the North-South Korea country-pair reached a certain level, the computer would automatically check and report back on the indicators for KON-CHN and KOS-USA.[50] An autoscan might

[50]Thanks to Steve Andriole for the concept--"Intelligent I&W"--of which autoscan is a part.

also include a report from the computer as to which countries had strong military commitments ties (as measured by Martin's index--Martin 1976 and 1977a) to the salient country pair.

Evaluation/Interpretation: This problem comprehends a great variety of issues found in both basic research and in the operational environment. Only a few are suggested here. There are massive problems with such things as separating signals from noise, interpretation of context, and weighting different indicators for military and political warning or monitoring systems considered independently.[51] These problems may be exacerbated by an amalgamation of such systems or by joint consideration of their signals.

However, amalgamation may also help solve problems of evaluation and interpretation. For example, the lead that political indicators generally have on military ones would suggest at least two paths of evaluation to an analyst faced with increasing verbal conflict for a particular country-pair.[52] First, he might pay closer attention to physical conflict as measured by political indicators as well as to other political indicators. Their performance should help him evaluate the "noisiness" of the verbal conflict. Second, he might track a variety of military indicators, especially those which have historically been best at longer term warning. Political indicators may not only provide longer lead time but they may help distinguish exercises from an actual conflict. Working the other way, political indicators may help unravel the context, may point to the target of elevation in a country's military indicator(s) when these indicators do not explicitly distinguish a potential target.

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[51] For illustrations of these problems as suggested by application of a political indicator system to two Middle East crises, see Daly (1978).

[52] For analysis and examples of the warning that verbal conflict gives of physical conflict see Davies (1978b).

Timing and Generalization: Both these problems have been illustrated by analyses of historical crises (Daly 1978). They are best discussed in the context of the problem of:

Thresholds: As illustrated in Figure 3-1, setting thresholds minimally involves considerations of hits, misses, false alarms, and correct rejections. However, the relative importance of these considerations varies widely depending on the purpose of the warning process. For example, the Early Warning and Monitoring Project is not yet responsible to crisis decision makers. We are therefore developing thresholds from analysis of historical hit rates of our indicators. (Daly and Bell 1977a; Daly 1977; and Davies 1977) For a real-world I&W analyst, however, these empirically derived thresholds may be associated with intolerable miss or false alarm rates. Eventually, therefore, the system must allow the analyst the option of setting thresholds himself and provide him with the implications (in terms of overall warning success) of his threshold based on historical empirical results. While determination of the development of extant military indicator systems is certainly not within our purview, research on threshold-setting with these systems would enhance and facilitate threshold-setting for the Early Warning and Monitoring System. If thresholds were developed for military indicators, a great deal could be learned by comparison and cross-checking of political and military indicator thresholds.

Other thresholding problems that have arisen with the political indicator system may occur with military ones as their coverage is expanded. Extensive research with the political indicator system suggests that:

- Even if retrospective analysis of interactions of the key participants in a particular pre-crisis period in a specific region seems to reveal sig-

nals or patterns leading to the crisis, it cannot be claimed that the system can provide warning of such events. One case does not a threshold make.

- It has been argued (Daly 1977) that the history of different regions and networks of countries necessitates development of region-specific indicators. If the indicator algorithms which provide the best warning and monitoring for a region differ from "global" algorithms, it is probable that any patterns which forecast cooperation or conflict in a region cannot be generalized.

Theory: The question--Is theoretical knowledge useful for warning or vice versa?--comprehends a variety of subissues, the most salient in the present context having to do with acceptance of interactive, computer-based warning and monitoring systems by the "typical" I&W analyst. The question as stated has already been answered in the affirmative; the problem is to demonstrate to analysts that there is a synergism between their "theory"--experience, expertise, traditional wisdom, non-quantitative training--and a system founded on methods in which they were not trained using computer technology with which they are unfamiliar.

Retrospective analyses (Andriole 1976a and 1976b; and Daly 1977) suggest that such systems could have provided warning of historical crises. In addition, such systems might help meet the information processing requirements of the I&W analyst and provide him with alternative estimates and indicators. Such systems are intended to assist, not replace, human judgment. The problem is to convince analysts that computer-based systems can assist them, can make their jobs easier. It must be demonstrated to analysts that quantitative indicator systems can supplement their years of experience, give them a different perspective on warning, enhance the prevailing theory, and even perhaps play a devil's advocate role.

There are, of course, several ways of obtaining user acceptance: training on extant computer-based systems, development of tutorial and expert versions, remaining cognizant of user needs and desires and designing the system to meet them in a flexible manner, and achieving demonstrable success in warning and monitoring. All these ways, and many others, of obtaining user acceptance must be explored so that we may demonstrate the synergism of I&W theory with interactive computer-based warning and monitoring systems.

4.2.4 Computer base.[53] This section documents the development of EWAMS software and describes its current status. The discussion will fall into two major categories: computer-based software and Tektronix 4051 standalone software. Table 4-43 provides a list of programs to be discussed under both categories, while Figure 4-20 graphically traces their evolution.

Computer-Based Software (Summary 1/76-1/77): In January of last year seven project support and test programs were surveyed. Summarily, the survey included (Wittmeyer 1977):

1. PROGRAM SCAN - used to collect total frequencies for sixteen actor nations from WEIS for 660101-691231.

2. PROGRAM REBUILD - used to construct a new data base of thirteen countries from WEIS. The reduced data base, written as a random file, contains all dyadic matches between the thirteen nations as actors and/or recipients and is used by program -CRISIS (now referred to as -THEN).

3. PROGRAM WINDEX - used to convert the sequential WEIS data set to a random access file to avoid a slow sequential search.

4. PROGRAM ARENA3 - used to count dyadic totals in any given region by day over ten years.

[53] This section borrows heavily from Bell (1978).

PROGRAM	COMPLETION DATE	LANGUAGE*	AUTHOR(S)
	Computer-Based		
-CRISIS(-THEN)	September 1976	SFO	Allen Wittmeyer Randall
PROGRAM WINDEX	July 1976	SFO	Randall
PROGRAM SCAN	March 1977	SFO	Wittmeyer
PROGRAM REBUILD	March 1977	SFO	Wittmeyer
PROGRAM ARENA3	March 1977	SFO	Wittmeyer
PROGRAM CROSST	March 1977	SFO	Wittmeyer
PROGRAM "ANALYZ"	March 1977	SFO	Wittmeyer
-NOW	January 1977	SFO	Wittmeyer
EFI	June 1977	RT-11	Wittmeyer
PROBS	July 1977	Fortran IV Plus	Bell
QCSI	July 1977	RT or RT-11	Wittmeyer Bell
THEN II	December 1977	Fortran IV Plus	Bell
UPWEIS	January 1978	Fortran IV Plus	Bell
NOW II	January 1978	Fortran IV Plus	Bell
	Standalone		
ROZ	July 1977	Basic	Wittmeyer
TENSION	September 1977	Basic	Bell
YULE'S Q	September 1977	Basic	Bell
PERCENT	November 1977	Basic	Bell Harrison
PROBE	January 1978	Basic	Harrison

*SFO is United Computing System's extended Fortran IV.

Table 4-43

EARLY WARNING AND MONITORING SYSTEM PROJECT SOFTWARE

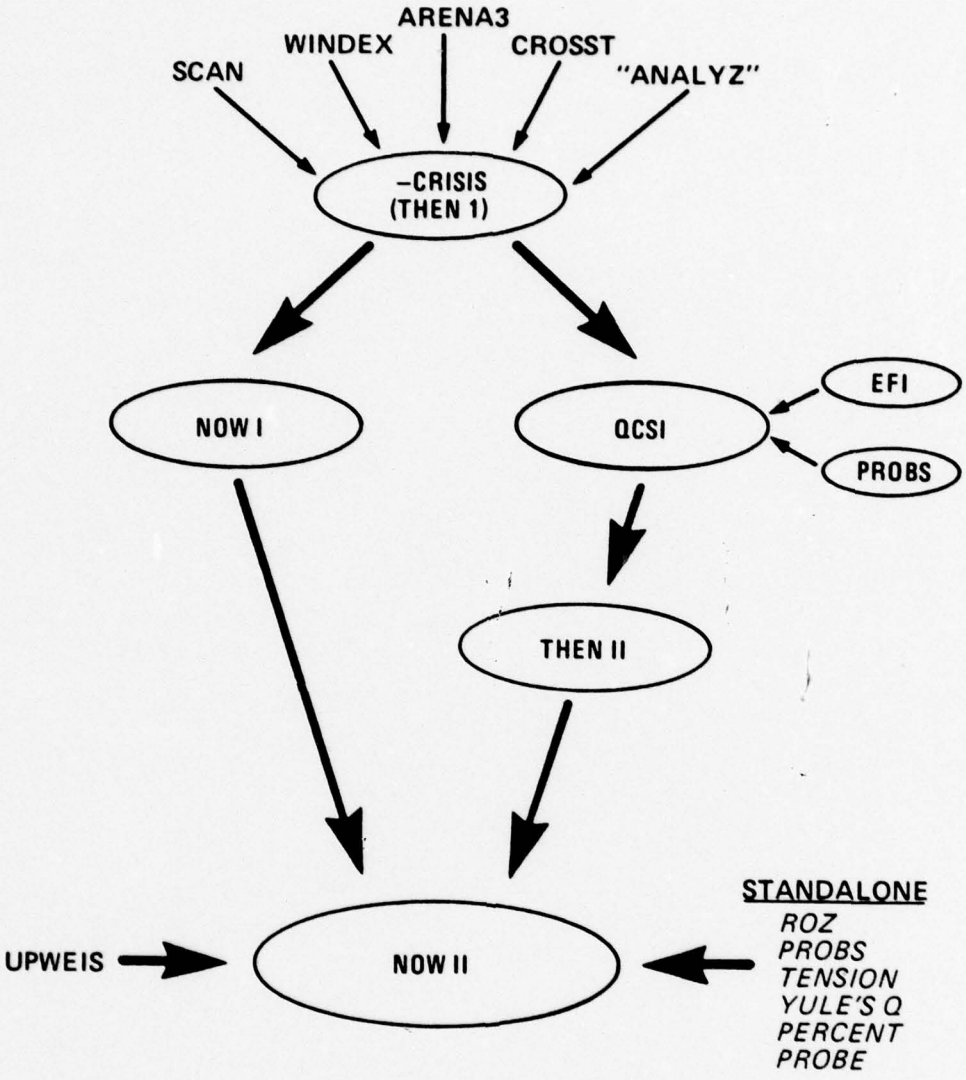

Figure 4-20

EARLY WARNING & MONITORING SYSTEM COMPONENTS

5. PROGRAM CROSST - used to read, collect, and output dyadic frequencies for three flow directions for six event categories by quarter over ten years.

6. Mutations of -CRISIS ("ANALYZ") - several modifications of -CRISIS addressed to a variety of experimental statistical procedures and data management processes.

-CRISIS, known to potential users as the "Historical Version" and to project staff as -THEN I, is described in detail in Software Design for an Interactive Crisis Early Warning Prototype System (Wittmeyer 1976). All the above programs were contributors to or spin-offs from -CRISIS. All of them, including -CRISIS, were developed and used on a commercial time-sharing system and were implemented in an extended Fortran language, UCS Super Fortran.

Computer-Based Software (Developments since January 1977):

-NOW: The master program -THEN I was joined in February 1977 by -NOW. Developed on a commercial time-sharing system, this version had all the features of -THEN but was front-ended by JCS regions and accessed all of WEIS, not merely the seven countries in -THEN I. It was comprised of eighteen 18 separate data sets. The program allowed the analyst to look at country pairs within JCS regions, a regional actor and any other country in the world or all countries in toto, the superpowers as a region, and to create his own region. -NOW was the "Real-Time Version" of the Early Warning and Monitoring Demonstration System. However, it was "real-time" only in terms of our latest WEIS data, at that time, through December 1976.

EFI: This was a preliminary attempt to modify McClelland's (1976) EFI indicator for the 11/70. The soft-

ware design developed then will be useful in adapting EFI as a systemic indicator in NOW II.

PROBS: This program was written to permit testing, evaluation, and dynamic modification of the Early Warning and Monitoring System probabilities.[54] PROBS is modular and lends itself easily to modification. Data availability necessitated that probability conversion tables be based on two-way interaction, crisis and non-crisis periods, progressive z-scores, and independent value groupings (class intervals). However, PROBS allows the analyst flexibility in selection of crisis cases, flows, type of z-scores, intervals, and "correction" factors.

PROBS employs a straightforward approach in its generations of probabilities. The program requires as input: a sequential copy of WEIS; the NATION file; and DOC (Dates of Crisis) file.

Output from PROBS includes: tables displaying the frequency of z-scores in crisis and non-crisis periods over any number of cases for total, cooperative, and conflictual categories; row percentages of z-scores at given levels and corollary probabilities; and the effect of various weighting factors on these probabilities.

Also included as output is a file 'DOUT.' If the analyst desires to see dyadic tables for each crisis case, he may obtain frequencies, z-scores, and probabilities for each case.

QCSI (Quality Control Safeguard): QCSI was a partial conversion of -THEN from a commercial time-sharing service to the DARPA/DDI PDP 11/70. The program was converted to the RT-11 Princeton Fortran language, modified for

[54] The source code for PROBS as well as a report on substantive findings generated with it can be found in Daly and Bell (1977b).

UNIX, and uses Plot-10 (TCS) graphics. QCSI consisted of four major programs simulating the overlay concept used in both -NOW and -THEN.

THEN II: THEN II was an upgrade of QCSI. Developed on CTO's Demonstration and Development Facility (DDF) PDP 11/70, it used the more extensive capabilities of Fortran IV-Plus and some of the graphics from -THEN.

UPWEIS: UPWEIS is used to update each record of the WEIS file to include regional codes for all initiators and targets. The updated WEIS file replaces the eighteen data sets used by the program -NOW. It therefore makes the JCS regional front end of NOW II much more efficient.

NOW II: NOW II is the current "master" version of the Early Warning and Monitoring System. It combines the best features of THEN II and NOW I, and adds some new ones, for example:

- a regional filter for JCS regions and build-your-own regions;
- AGII graphics (less the calendar data feature);
- daily data from 1966 to the present;
- descriptive data.

In its current configuration NOW II is the master version into which tested and evaluated research results are integrated. Examples of such results include improved indicator algorithms, new political indicators such as regional EFI and regional ROZ, moving windows, and different combinations of plots. For the present, major research and development efforts such as those on military and economic indicators will be kept separate. It must always be kept in mind, however, that political, economic, and military indicators must all eventually reside in an integrated Early

Warning and Monitoring System. All research should be designed to facilitate this integration.

Software on the Standalone 4051: Much project software also runs on a standalone Tektronix 4051. This software serves a dual purpose. First, the results of research done with many of these programs has been or will be integrated into the master version, NOW II. Second, all the software is interactive and virtually self-explanatory so that it can be used not only by project analysts but by potential users in the Intelligence Community as a supplement to their efforts on -NOW II. All the standalone software is written in BASIC. ROZ requires an 8K machine while the other programs require 32K.

ROZ: A PDP 11/70 was used to generate monthly frequencies of events initiated by each of 183 countries from January 1976 to March 1977. This output was generated by a program which checked each event and matched the initiator's country code against its position in the NATION file. If, for example, the initiator nation was RHO (Rhodesia), then it was matched and placed in the proper 124 position. This was done for each of the fifteen months for all 183 nations, organizations, and groups.

The process that followed was also very straightforward:

1) A program was written to input this data matrix (fifteen months by 183 nations) to a 4051 internal cassette tape.

2) A data check program was used to test the validity of the file created in Step 1.

3) A utility copy program was written to insure a back-up copy.

4) Finally, a standalone BASIC program was written that would read the data tape, search for an individual nation (in order of the NATION file),

and calculate z-scores and ROZ output based upon the percentage of events initiated by that nation for the given month. One other required input to the standalone ROZ is McClelland's number--the percentage of total events of that country for the period 1966-75 (McClelland 1976).

Although written in BASIC, a version of the standalone ROZ program can and will be converted to FORTRAN on the DDF PDP 11/70 in the near future. One area to be explored is a combination of an improved version of the summary and frequencies program (by any time increment) with the conversion of the ROZ routines to FORTRAN to display a rank order of the most volatile to least volatile nations. The resultant program would provide a barometer-like capability which would allow the user to see which countries are or are not upsetting the world systemic flows.

TENSION: Like ROZ, the results of the standalone program TENSION have improved the master version of the Early Warning and Monitoring System residing on the DDF 11/70. TENSION was written to permit research for improving the tension indicator. It is interactive and allows the analyst to calculate tension levels for any country-pair, flow, and time period, and to designate crisis periods. The analyst can apply any or all of four weighting factors to the data. The findings generated with TENSION have resulted in modification and improvement of the tension algorithm in the master version and have been used to examine regional tension in the Mideast (Daly 1977).

YULE'S Q: While YULE'S Q[55] was initially written to continue the research begun with TENSION, it is independent of the latter and, especially in its second generation

[55]For source code, see Daly and Bell (1977a). For substantive findings based on the program, see Daly and Bell (1977a) and Daly (1977a).

as PERCENT, has a great variety of current and potential applications.

Yule's Q is a measure of association for 2X2 tables. It was initially used to compare the historical correspondence between indicator signals and reality for twenty-seven crises and thereby to evaluate the alternative tension levels generated with TENSION. The program allows the analyst to calculate Yule's Q over as many cases as desired and for various weights and thresholds. The program also calculates the percentages of hits, misses, false alarms, correct rejections, and the overall success rate for the selected combination of cases, weights, and thresholds.

PERCENT:[56] Like YULE'S Q, its successor, the program PERCENT, has applications far beyond its initial purpose. The program was written to permit more detailed analysis of the 2x2 tables generated by TENSION and analyzed by YULE'S Q. It calculates row, column, and total percentages over any number of cases for both weighted and unweighted tension and for a variety of thresholds. The program has allowed us to evaluate many tension algorithms and thresholds and to determine the most valid and reliable one. Results of this research will be integrated into the master version of the Early Warning and Monitoring System. PERCENT can be used to perform similar research and evaluation on other indicators.

PROBE: Program PROBE is designed to allow the analyst to examine the pattern of cooperative and conflictual events in crisis and non-crisis periods. PROBE computes and displays in tabular and graphics format probabilities for all twenty-two event types. Preliminary research using this program indicates that new quantitative political

[56]For details on this program see Davies (1977).

indicators based on verbal and physical event types substantially improves the warning and monitoring capabilities of the system.

Software Plans--11/70-Based: Modifications will continue to be made to NOW II, the master version of the Early Warning and Monitoring System. These will be relatively minor and incremental, reflecting results of research on specific and narrow aspects of the system. On-going and planned research efforts whose results will eventually quietly appear in NOW II include:

- probability plots
- global and regional EFI
- rates of change
- thresholding all indicators
- probs from tension
- a modified HREL, or indicator to replace it
- all vs. all indicators
- moving windows
- research with special data sets
- ROZIN and REGROZ
- regional HREL
- maps
- daily data
- autoscan.

Work will also continue on economic, military, domestic, and cross-national[57] indicators. These efforts

[57]For details on domestic and cross-national indicators see Wilkenfeld and Hopple (1977).

will be kept separate from NOW II. When rigorous testing reveals that economic, military, and/or domestic indicator systems are sufficiently developed to be integrated with international political ones, NOW II will die and be replaced with a new version of the Early Warning and Monitoring System, hopefully one with a more euphonious appellation. Writing the software for such an integration will be a formidable task, made feasible only by designing and developing a new version of the warning system.

Software Plans--Standalone: Given the existence of DDF, the last year's emphasis on standalone research and test programs will decrease. However, attention to standalone capabilities will continue in two forms.

First, the availability of the Tektronix 4097 floppy disk renders the development of a standalone Early Warning and Monitoring System demo eminently feasible and practical. A 4051/floppy combination means that the system can be shown to (and even eventually used by) potential users anywhere in the world who have no access to a host computer.

The 4907 is a direct access, flexible disc device for the 4051. It is built around a microprocessor to handle file management and directory tasks. Single, dual, and triple disc drives are available allowing up to 1.89 million bytes of storage.

The floppy will permit data transfer, sorts and merges to be accomplished with a minimum of programming. Program overlaying, chaining, and appending are performed in a fraction of the time required when using the tape storage. Directory and file management capabilities allow ease in storing and retrieving programs and data files.

Overall, the 4051 coupled with the 4907 will serve as a compact computing system with local control, convenient storage medium, and enough computing power to adequately "substitute" for a large computer system.

The second thrust of a continued standalone effort will focus on a compilation of utility packages to aid project analysts as well as potential users in the Intelligence Community. Admittedly, not all of those to whom the System is transferred will have any desire to go beyond the options in NOW II. For those who do however, we should be prepared to provide interactive, easy-to-use routines compiled in an Analyst Research Assistance Package. Such a package might include the extant TENSION, YULE'S Q, PERCENT, and PROBE as well as simple statistical routines. As with all aspects of the Early Warning and Monitoring System, we shall continue to solicit input from potential users on ways in which the 11/70-based and standalone software might better address their needs.

5.0 DEMONSTRATION AND TRANSFER OF THE EARLY WARNING AND MONITORING PROTOTYPE SYSTEM

5.1 Demonstration

Appendix C presents a partial listing of those who have viewed an EWAMS demonstration. Since DDF allows access to EWAMS from anywhere in the country (including DIA/NMIC), the list of those who have seen the demo and experimented with EWAMS is undoubtedly much longer.

The development and demonstration versions of EWAMS are currently one and the same. This, plus the excellent facilities of DDF and the support of its highly competent personnel, means that potential users are exposed to EWAMS "state of the art." Furthermore, improvements and modifications are immediately available to users. This is beneficial to project staff since users, e.g., at DIA/NMIC, can provide instant evaluations on modifications to EWAMS.

5.2 Transfer

Transfer of EWAMS to one user group is currently being conducted under the terms of the ARPA/DIA Memorandum of Understanding. It is anticipated that transfer to other parallel, off-line testbeds will occur at the direction of the COTR.

DIA/NMIC currently accesses EWAMS on DDF with a Tektronix 4051 in the NMIC. Supervisory personnel have been

trained on EWAMS and they in turn, along with project personnel, are introducing the system to NMIC analysts. A forthcoming EWAMS Users Manual will supplement the informal, ad hoc transfer process. The informality of the transfer process has been of great benefit to the development of EWAMS. User needs and desires have been easily solicited and translated into system modifications.

All potential users who see the system are queried as to whether they would rather have a "novice" or "expert" version of the system. A novice, tutorial version for the inexperienced would have step-by-step instructions and lists of options. It would also be fairly rigid in terms of ordering of analysis and would require a fairly large computer capacity. An expert version of the system would be very flexible, allowing the user to jump from one type of analysis to another with simple one-word commands. Either, both, or a compromise system can be designed with input from potential users being the key consideration.

In addition to maintaining maximum user ease and flexibility, the software is being developed with the objective of maintaining maximum compatibility with the hardware and software of both potential users and of other computer-based projects in the Crisis Management Program. The technical, though not necessarily operational, goal is a computer-based, fully-integrated crisis early warning/management system.

The packaging and distribution of EWAMS software is compatible with CULC Fortran IV-Plus for UNIX and AG II graphics. At CTO request and the directions of the COTR, we are consulting and assisting in the conversion and transfer of the PDP 11/70 software to user facilities.

6.0 THE BLEND OF EMPIRICAL AND DECISION ANALYTIC I&W

6.1 Current Status

The blend of empirical and decision-analytic methodologies for I&W is still in the basic research stage. The next section illustrates some problems with development of the blend, while Section 6.3 discusses its potential. Since DIA/NMIC is currently using decision-analytic aids and models, research on the blend of methodologies has been facilitated by the ARPA/DIA Memorandum of Understanding. In the NMIC context, blend research is focusing on the conceptual linkage of empirical and decision-analytic models, indicator scale conversions necessary for such linkage, and retrospective analyses of historical case studies using both methodologies.

In the context of the Early Warning and Monitoring Project, the purposes of the blend of empirical and subjective methodologies are to: 1) generate additional indicators for I&W and to test and evaluate extant ones; 2) compare and evaluate empirically and subjectively generated probabilities; 3) generate, compare, and evaluate utilities produced with the two methodologies; and 4) provide the Defense community with a flexible and efficient tool combining the best of two separate but synergistic methodologies for I&W.[1] Underlying

[1] For more on these purposes and methodologies, see Andriole (1976a) and Decisions and Designs, Incorporated (1977a).

these purposes is the assumption that indicators, probabilities, and utilities derived with two independent methodologies can be compared and evaluated in parallel, linked component by component, and perhaps eventually integrated both logically and in a single computer-based system. The research on indicators, probabilities, and utilities is serving to confirm or disconfirm the assumption. Initial research is in the form of case studies to explore the compatibility of two decision analysis models and one Bayesian hierarchical inference model with the empirical data, indicators, and probabilities of the Early Warning and Monitoring Project.

6.2 Problems

From the perspective of the Early Warning and Monitoring Project, there are several problems or criteria for evaluation of the compatibility of decision-analytic models[2] with the project's empirical data, methods, and output. Without categorizing them as ideal, desirable, necessary, or sufficient, these non-mutually exclusive criteria are product, dynamism, probabilities, thresholds, flexibility, and input data.[3] More specifically, the criteria of compatibility refer to:

> Product: Is the output of the model addressed more to decision making or to monitoring and forecasting, i.e., to determination of the best option or system or to determination of the likelihood of an event? Those familiar with decision-analytic models are aware that "either/or" statements of their products are inaccurate; however, examination of the models in terms of the above criteria suggests their products can be placed at different points on a continuum. In the present stage of development of the Early Warning and Monitoring

[2] For the sake of brevity, "decision-analytic models" refers also to Bayesian hierarchical inference ones.

[3] Decision analyst readers are forewarned that these criteria have been developed by novices in decision analysis and are based on examination of only three models--EVAL, OPINT, and HIER.

System, a model whose product emphasizes forecasting or facilitates warning is preferable.

Probabilities: Empirically generated probabilities of conflict and crisis are a key feature of EWAMS. A decision-analytic model featuring probabilities would greatly facilitate comparative testing, evaluation, and blending of empirically and subjectively-generated probabilities and the indicators and data underlying them.

Thresholds: Much more research needs to be and will be done on the establishment of warning thresholds and hit and false alarm rates for empirical indicators. Decision-analytic models with the capacity to determine thresholds and to evaluate hit and false alarm rates will facilitate such research and development.

Flexibility: This is a catch-all category covering considerations of model logic, user ease, and the compatibilities of model computer bases.

Input Data: How much theoretical surgery must be performed on decision-analytic models to allow direct input of empirical data rather than just analyst assessment of it?

6.3 Potential

It is possible to integrate, at least conceptually, decision-analytic models, Bayesian Hierarchical Inference (BHI) ones, and empirical ones.

Such integration can be approached in a variety of ways. One possibility is to have empirical indicators and probabilities feed a BHI model which in turn would feed a decision-analytic option selection and evaluation model. In this instance, the output from the Early Warning and Monitoring System would serve both as long-range predictors to focus a BHI model and as observable data for that model. The BHI model would in turn serve as input to probability assessment of uncertain events affecting outcomes in the decision analysis model. As the situation to which the models are addressed evolves over time, the evaluation of options would consist of a comparison of changing proba-

bilities with the thresholds established by the decision rules to identify points in the dynamic situation at which the expected value of options might change. Figure 6-1 outlines this general scheme as applied to a Lebanon evacuation.[4]

Another possibility is to have the BHI and empirical models run in parallel. This would serve a corraborating function and allow the decision maker to choose the probabilities he felt most suitable to specific uncertain events in his decision model (see Figure 6-2).

A third possibility reverses this linkage. It should be possible, conceptually at least, for a BHI model to feed the Early Warning and Monitoring System. For example, a BHI model of long-range Arab strategy toward Israel might hypothesize peace, limited military action, and risk of prolonged war. The hypotheses would refer to a relatively long time span, and the model would include general political, economic, and military indicators.[5] Thresholds for the transition from peace to one of the other hypotheses might be established subjectively, through retrospective analysis, or by use of the model over time. If the established probability threshold were crossed, the analyst would then activate the Early Warning and Monitoring System and focus on the relevant countries or country pairs. Thresholds could in turn be set for the Early Warning System indicators and probabilities. Crossing of these thresholds might be used as a signal to activate a BHI short-range Military Posture Model to be used in conjunction with the empirical model.

The intelligence component of other decision analytic models could also be used to feed the empirical system.

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[4]Details of this linkage can be found in Decisions and Designs, Incorporated (1977b).

[5]For an example of BHI models of North Korean long- and short-range strategies and their linkages, see Stewart et al. (1976).

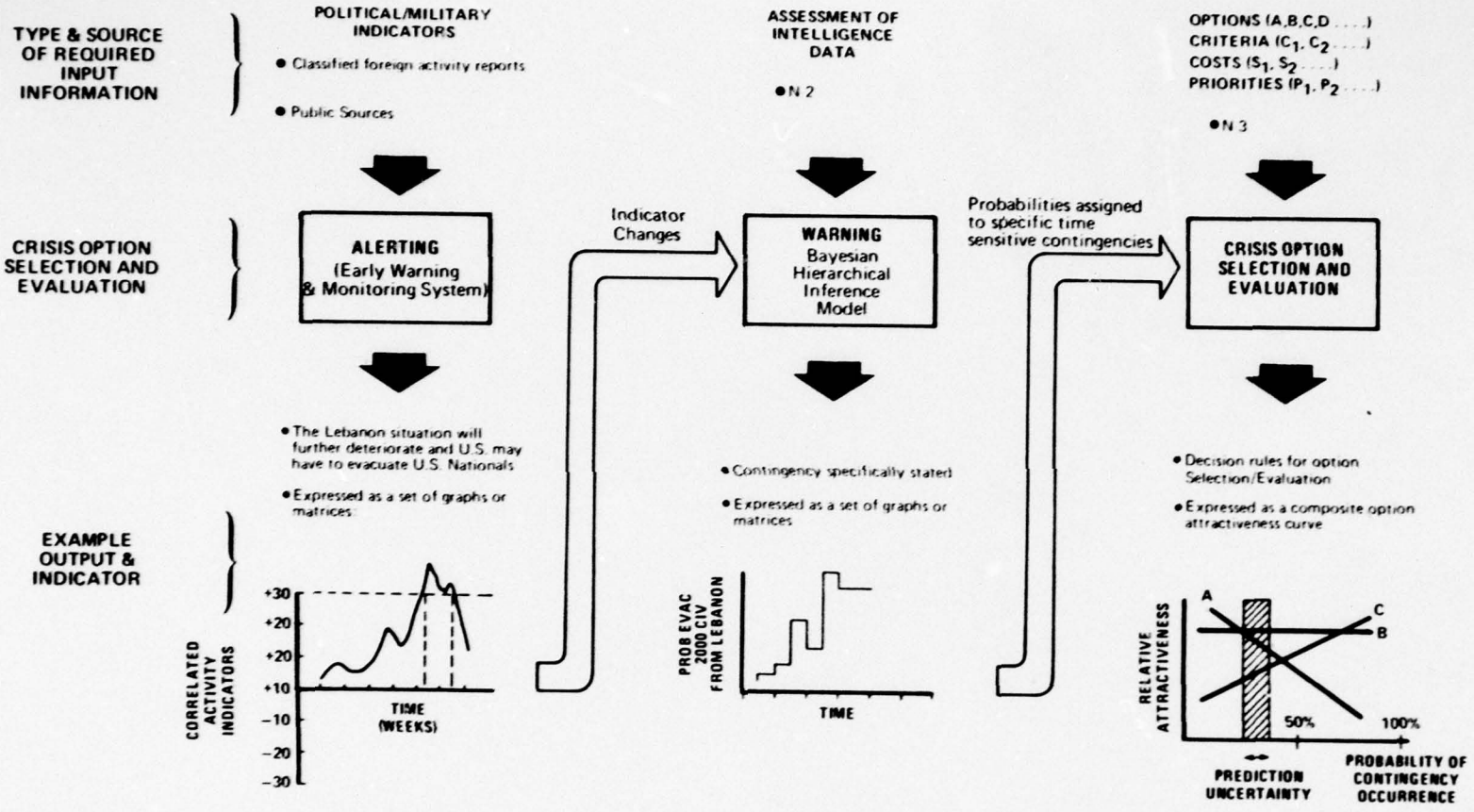


Figure 6-1

LINKAGE OF EMPIRICAL, BMI, AND OPTION SELECTION MODELS – 1

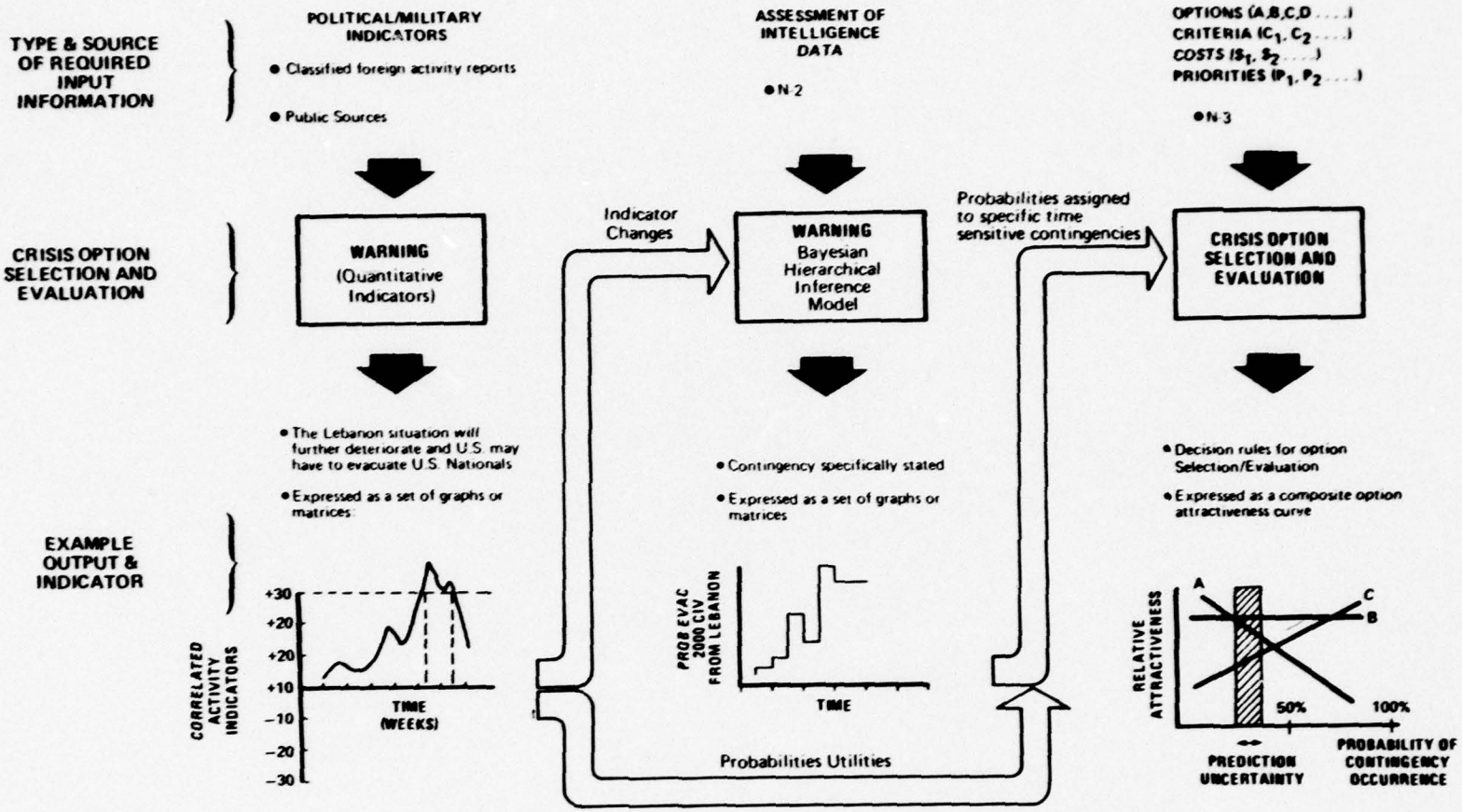


Figure 6-2

LINKAGE OF EMPIRICAL, BMI, AND OPTION SELECTION MODELS – 2

With logic similar to that above, thresholds could be established for event likelihoods. Changes in these subjectively generated event likelihoods could be used to trigger the empirical system.

A final vehicle for the blend is less comprehensive than the possibilities discussed above, but can be implemented and tested more quickly. If the analyst using the Early Warning and Monitoring System wishes to examine the actual events on which its probabilities, indicators, and numbers are based, he can call up a narrative description of those events. The verbal descriptions could serve as a supplement to his expertise and as an input to alter the empirical probabilities generated by the system. The analyst would alter the probabilities by relying on what he reads and on his expertise rather than by accepting what the indicators and probabilities aggregated from these events tell him. The Early Warning and Monitoring System would thus have an option for subjective control of its own estimates and would also provide part of the input to control by the expert.[6]

As with most endeavors, it is likely that the blend of the empirical I&W system with decision-analytic models will be rather more difficult to accomplish in practice than to describe. Difficulties will be the result not only of differences in logic and concept but of the distinctive computer bases of the two methodologies.

While diverse decision-analytic models can be evaluated in terms of product, dynamicism, probabilities, thresholds, flexibility, and input data, none has been designated as the "best" vehicle for the blend. Each has features which would make it amenable to a blend; each has weaknesses which would constrain integration. Given that one of the purposes of

[6]See Andriole (1976b) for the origin of this idea.

the blend is to provide the potential users in the I&W community with an efficient and flexible amalgam of the features of two distinct but complementary methodologies, perhaps the choice of vehicles should be left to them. They are the best judge of the form(s) of the blend which would meet their needs. The role of those researching and developing the blend would then be to provide users with alternatives and to help them to tailor their choices to their specific needs. Whatever their choice, some integration of empirical and subjective methodologies for I&W (and potentially operations) will provide users with a more effective tool than independent application of the methodologies.

7.0 FUTURE RESEARCH

There are three complementary yet separable paths which future research with the Early Warning and Monitoring System will or can take. These are: (1) implementation of EWAMS design, (2) "Intelligent" I&W, and (3) an I&W/Operations link.

7.1 Implementation of the Early Warning and Monitoring System Design

The future research path that will be pursued most rigorously and intensively is development, testing, and implementation of the system design illustrated in Figure 7-1. Development of each of the three systems comprehended by EWAMS--information retrieval, warning, and monitoring--will continue. Development, testing, and evaluation of the components

- o general scans,
- o quantitative political, military, economic, and domestic indicators,
- o forecasting methods, and
- o computer base

is on-going and will continue. The methodological and bureaucratic strategy outlined in Section 3.0 for making the transition from a monitoring to a warning system will be pursued.

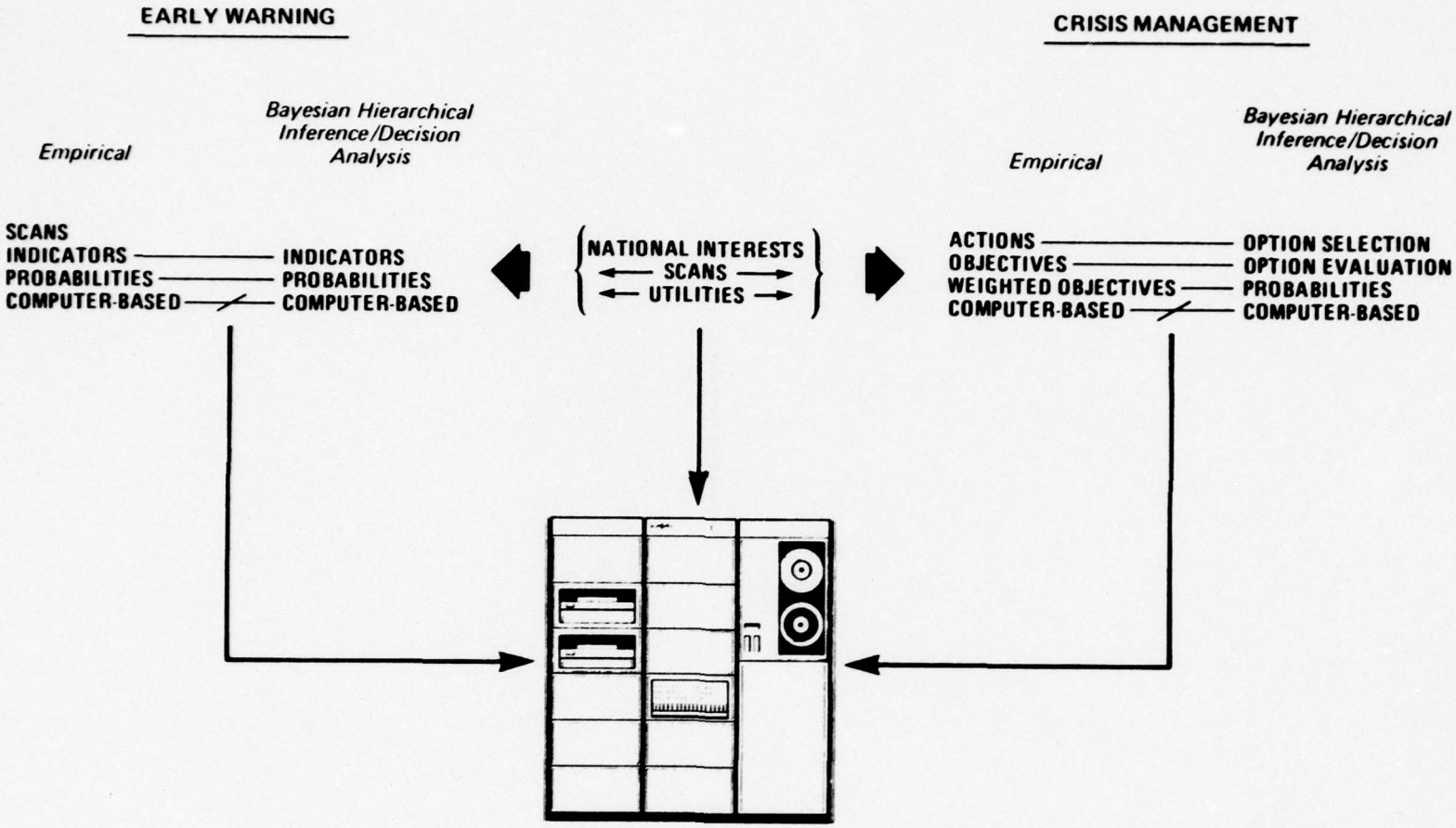


Figure 7-1

RESEARCH DESIGN FOR A CRISIS EARLY WARNING/MANAGEMENT SYSTEM

7.2 "Intelligent I&W"

The obstacle to implementation of this component of EWAMS design is not bureaucratic; it is the very large amounts of time, money, effort, hardware, etc. required. "Intelligent I&W" is the rubric for a number of complex and diverse enhancements that should be made to EWAMS to increase its efficiency and utility to the I&W community. "Intelligent I&W," which may at present resemble a "wish list" more than a concept, may be broken into intranational and international arenas. Figure 7-2 suggests components of the former and Figure 7-3 the latter, while Figures 7-4 and 7-5 show what output for each might resemble.

"Intelligent I&W" is the logical extension of the EWAMS design. While it may seem like a list of enhancements rather than a new concept, it is evident that development, testing, and implementation of the Intelligent I&W idea will require large amounts of manpower and money for design and programming. However, the payoff in terms of improved analyst efficiency and performance would seem to justify the cost.

7.3 I&W/Operations Link

Given contractual guidelines and bureaucratic politics, future research on linking I&W and operations activities--or more specifically, crisis warning and management--must remain in the realm of the possible. However, the existence of the hardware-compatible EWAMS and an Executive Aid for Crisis Management (CACI 1977) as well as the conceptual linkage sketched below, offer at least a partial foundation for any future research.

7.3.1 Establish requirements of a crisis warning and management system. Arguments about the relative utility of

ALERT LIST = AUTOMATIC

- *Tracking of countries for which system indicators have crossed warning thresholds*
- *Identification of characteristics of disturbance, EG, source, military, political, economic issue area; target; form*
- *Calculation of probability that domestic conflict will expand*

SEARCH FOR SIMILAR HISTORICAL PATTERNS

- *EG, a domestic tension > 70 for Poland, sparked by food riots, can trigger output for magnitude, intensity, duration and outcome of previous food riots*

ANALYSIS OF POTENTIAL EVOLUTION OF DISTURBANCE = AUTOSCAN FOR

- *Contagion possibilities*
- *Magnitude*
- *Intensity*
- *Forms*
- *Targets*

MAINTAIN COUNTRY PROFILES

- *Decision-maker characteristics and values, government instability and societal unrest indices, economic performance, demographic characteristics*

RECOMMEND COLLECTION PRIORITIES

- *Based on all the above, flag needed changes in collection targets and methods for alert list countries*

Figure 7-2

COMPONENTS OF INTELLIGENT I&W (Domestic)

- ALERT LIST
  - AUTOMATIC TRACKING OF WORLD, REGIONS, COUNTRY PAIRS FOR INDICATOR THRESHOLD CROSSINGS
- INDICATORS
  - AUTOMATIC ACTIVATION OF MILITARY, ECONOMIC, AND INTRANATIONAL INDICATORS FOR ALERT LISTINGS
- HISTORICAL PRECEDENT SEARCH
  - E.G., A USSR-CZECH CRISIS PROBABILITY OF >.70 TODAY WOULD TRIGGER OUTPUT OF 1968 INVASION
- THREAT NETWORKS
  - E.G., A NORTH/SOUTH KOREAN TENSION LEVEL OF 80 WOULD TRIGGER EXAMINATION OF TENSION BETWEEN US AND SOUTH KOREA AND USSR AND NORTH KOREA
- DATA COLLECTION
  - SYSTEM AUTOMATICALLY SIGNALS CHANGES IN COLLECTION PRIORITIES

Figure 7-3

"INTELLIGENT" I&W SYSTEM
(International)

***** EARLY WARNING AND MONITORING PROTOTYPE SYSTEM ACTIVATED *****

ALERT LIST (Domestic)
31 January 1978

1. Italy
2. Iran
3. South Africa
4. Nicaragua
5. Indonesia
6. Northern Ireland

A system indicator for the above countries crossed the warning threshold at 0500 today. Automatic system evaluation indicates that the primary characteristics of the internal disturbance and the probability of expanded danger in these countries is as follows:

Italy--Anti-government demonstrations by left-wing political groups (.73)
Iran--Violent clashes between pro and anti-Shah groups (.44)
South Africa--Scattered anti-apartheid terrorist bombings (.74)
Nicaragua--Sporadic riots sparked by assassination of opposition newspaper editor (.59)
Indonesia--Widespread arrests and detention of student dissidents (.42)
Northern Ireland--Renewed bombing of protestant targets by IRA members (.50)

The system will continue to monitor these domestic situations. Evaluations will be updated and reported as new information becomes available.

Figure 7-4
ALERT LIST (Domestic)

***** EARLY WARNING AND MONITORING PROTOTYPE SYSTEM ACTIVATED *****

ALERT LIST (International Political)
31 January 1978

1. Somalia-Ethopia
2. Somalia-USSR
3. Italy
4. Middle East
5. Israel-Egypt
6. EFI

The above countries, country-pairs, and regions crossed the warning threshold of a system indicator at 0300 today. The contagion potential of the above danger areas has been automatically analyzed and can now be reported. Possible contagion networks include:

For--
1. Eritrean Liberation Front
2. USSR-USA, Cuba-USA
3. Italy-USA, France-Italy
4. ROZ for all region members
5. USA-Israel, USA-Jordan, Jordan-Israel, Jordan-UAR

Do you want to examine other contagion possibilities? N

Figure 7-5
ALERT LIST (International)

crisis warning and crisis management studies are a misuse of scarce resources. The two are so related that advances in one benefit the other: adequate early warning facilitates planning for and managing of crises; good management informs and directs early warning. One of the many ways in which warning and management systems can supplement each other is illustrated above. Warnings can be generated from quantitative indicators or from BHI techniques. The probabilities and utilities generated from either or both can feed into an interactive computerized crisis management system. This system can be based on empirical or qualitative methodologies for the selection and evaluation of crisis management options. Ideally, the crisis management system (as well as the early warning system) would be comprised of a blend of subjective and objective techniques.

Another way in which crisis warning and management are related is through the concept of national interests. As discussed in Section 3.3.3, quantified interest indicators can be used in early warning to narrow and specify the analyst's scans for crises. They can be used in crisis management to examine the utilities of the U.S., allies, or adversaries involved in the crisis. The link between forecasting and management provided by a quantified national interest concept is indicated in Figure 7-6.

Delineation of a country's interests is of little use for planning and crisis management unless it is supplemented by an estimate of associated risk and potential loss to those interests. Such an estimate would also enhance forecasting capabilities by allowing the analyst to further specify his scan. An assessment of associated risks and potential costs resulting from developing crisis could be done with either objective or subjective techniques--or both. Furthermore, an assessment could be done for just the U.S., the U.S. and its allies, or all possible participants

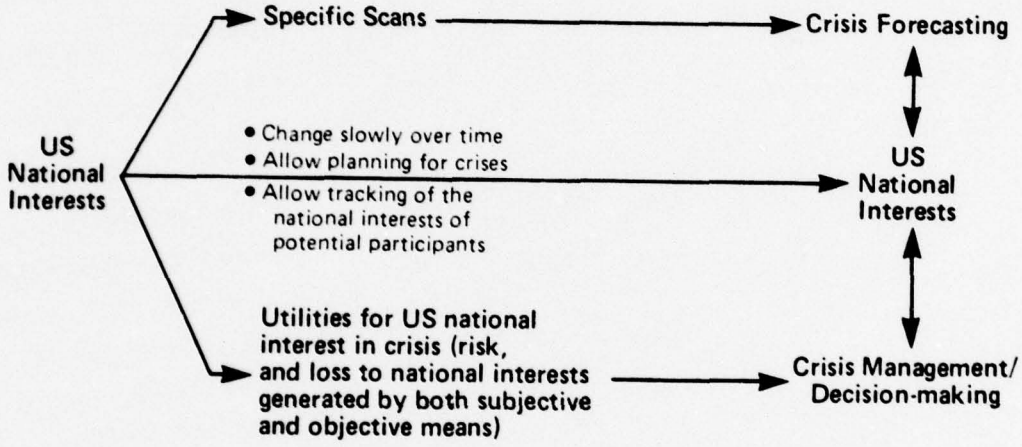


Figure 7-6

THE NATIONAL INTEREST LINK
BETWEEN CRISIS EARLY WARNING AND MANAGEMENT

including adversaries. A national interest assessment for all possible participants would be of great use to U.S. planners and crisis managers. Knowledge of the risks and potential losses associated with specific national interests of all participants would be very useful for U.S. participants in crisis bargaining and negotiations, as would an algorithm for optimizing U.S. interests and utilities in different types of crises.

Categorization of national interests according to their military, political, or economic nature will also be useful to various types of users. Interests not only differ substantively, but also in terms of the concern with which they are viewed by various levels in different agencies. For example, on the global level DoD has an immediate as well as a long-term concern with military national interests. National level commands also have a concern with long-term political and economic interests as they potentially impinge on military interests. The concern of theatre level commands is less comprehensive in terms of both substantive interests and time. Other agencies concerned with crisis early warning would place different priorities on national interests. For example, the Department of State would be more concerned with the economic and political national interests of participants in a potential crisis than with military interests. The inclusion of indicators of several types of national interests in the third-stage prototype system will broaden its appeal to potential users.

Midway between warning and management is contingency planning for crises. As several quantitative studies, e.g., Breemer (1974), Martin (1977a), and the Threat Recognition and Analysis Project (McClelland, McGowan, and Martin 1976) have demonstrated, national interests change relatively slowly over time. Thus once current

interests, whether military, political, economic, or cultural, are delineated, to a certain extent contingency plans can be based on them.

Delineation of U.S. national interests should provide an indication of the countries or organizations with which the U.S. is likely to become involved in a crisis. This is a part of the warning function national interest indicators can provide. It also suggests that the national interests of those countries and organizations should be monitored. This would give U.S. planners a jump on assessing potential risks and losses to our own as well as adversary national interests in a future crisis. It would thus facilitate the planning of bargaining and negotiation strategies.

A fully integrated crisis warning system would be user-oriented, computer-based, and be comprised of both subjective and objective methods for crisis early warning and management. In addition to the link provided by quantitative indicators of national interests, warning and management capabilities would be integrated by the extension of the blend between empirical and decision-analytic techniques for early warning to be developed in the third-stage early warning system.

In addition to a synthesis of methodologies, the early warning blend will require conversion and integration of currently operationally separate hardware and software. If this can be accomplished, development of a fully integrated warning/management system will be greatly facilitated. In short, in addition to conceptual and methodological requirements, a crisis warning and management system would require conversion of capabilities of the IBM 5100, on which subjective techniques for early warning and management are now dependent, to the PDP 11/70 and Tektronics 4051 graphics

terminal configuration on which objective techniques for warning and management are dependent.

7.3.2 Evaluate warning and management goals and methods. The ultimate goal of extant computerized warning and management systems is the same--to enhance U.S. security. The differences between empirical and subjective methods for early warning described above are also found in computer based systems for crisis management. As illustrated by the Korean and Lebanon evacuation models described above, crisis management can be addressed by subjective techniques. As the computer-based executive aid developed by another Crisis Management Program contractor (CACI 1977) illustrates, crisis management problems can also be addressed with empirically based techniques.

If the blend between subjective and empirical indicators, probabilities and utilities now being tested demonstrates that the methodologies are complimentary and synergistic, the same blend should be evaluated for crisis management. This testing and evaluation should, of course, be preceded by rigorous and separate testing and evaluation of the two techniques for crisis management in themselves.

7.3.3 Examine computer capability for interactive crisis warning and management system. In parallel with the above explorations, examination of ways to integrate separate hardware and software configurations must be examined. Given the goal of a fully integrated crisis early warning and management system, which would require large computer capacity, it is likely that IBM 5100-based techniques will have to be converted to PDP 11/70-based technology. In addition to its probable necessity, such a conversion is also desirable because of the graphics capability of the 11/70 and the 4051.

Some views on the relationship between warning/monitoring and action/decision contend that a warning must not merely be given, but be acted on to be a success. Henry Kissinger has been quoted as saying, "A warning is not a warning until it reaches me." This can serve as a summary statement of a variety of problems that arise with the attempt to connect warning to action, whether operationally or conceptually. There are at least five operational reasons why a warning may never be connected to an action:

1. the event was unknowable, i.e., lacked even theoretically perceivable precursors;
2. critical gaps in available information;
3. communication inadequacies;
4. consumer failures; and
5. analyst failures.[1]

To an extent, the Early Warning and Monitoring System can ameliorate all these problems except the first one. For example, if the system were installed in more than one I&W center, its output could provide a standard language for communication. As suggested above, system indicators might also mitigate analyst failures by playing a devil's advocate role.

Conceptually, it is possible to go even further with the warning-action link by designing an integration of computer-based warning and crisis management systems such as illustrated in Figure 7-1. However, such conceptual designs are likely to run into bureaucratic brick walls. Perhaps if it can eventually be demonstrated that the Early Warning and Monitoring System can contribute (in a narrow, ad hoc manner) to an operational linking of warning and action, prototypes representing more ambitious conceptual links could be gradually

[1] For elaboration of these reasons, see Shryock (1977a, 1977b, and 1977c).

installed in test beds in an attempt to facilitate greater communication between operations and intelligence bureaucracies.

APPENDIX A

Sample Output

********** EARLY WARNING AND MONITORING SYSTEM **********

The Early Warning and Monitoring System was originally developed for the Defense Advanced Research Projects Agency's Cybernetics Technology Office (ARPA/CTO) by Decisions and Designs, Incorporated (DDI); current development is being performed by the International Public Policy Research Corporation (IPPRC).

This version of the system shows how a computer-based warning system comprised of quantitative political indicators might be used by intelligence analysts in "real-time" to monitor international affairs and forecast international crises. The analyst can use the system to track single countries, country-pairs, JCS regions, regions of his own creation, or the entire international system. The system includes data from 1966 to the present so that the analyst can do historical analyses if he so desires.

Future versions of the system will add quantitative military and economic indicators to the political ones to give the analyst a multi-track indicator system for early warning and monitoring.

****

Please press RETURN to activate the system:

```
*** EARLY WARNING AND MONITORING SYSTEM ACTIVATED ***

Are your actors:
    1. Countries
    2. JCS regions
    3. Both          1

Please select two countries(usa,usr):  usa,war

Specify activity flow:
    0. one way (usa )>> war)
    1. one way (usa <<( war)
    2. two way (usa <-> war)  2

Select time increment:
    1. monthly
    2. quarterly
    3. yearly                 1

Set time parameters(7501-7712):  7701-7805
```

```
**************** 8. Warsaw Pact ****************

    albania                          (alb)
    bulgaria                         (bul)
    czechoslovakia                   (cze)
    germany/dem rep                  (gme)
    hungary                          (hun)
    poland                           (pol)
    rumania                          (rum)
    ussr                             (usr)

************************************************

Press RETURN to continue:
```

PROCESSING
COMPLETED

Number of events found: 728

Do you desire 30 day probablistic forecasts(y/n): y

Monthly Probability
Jan, 1977 - May, 1978

usa <<<>>> war

Date	Probability
Jan 77	.10
Feb 77	.10
Mar 77	.23
Apr 77	.48
May 77	.10
Jun 77	.23
Jul 77	.10
Aug 77	.10
Sep 77	.10
Oct 77	.10
Nov 77	.10
Dec 77	.10
Jan 78	.10
Feb 78	.23
Mar 78	.10
Apr 78	.10
May 78	.48

Press RETURN to continue:

SYSTEM OPTIONS :

tables	-	(tabular output)
plots	-	(graphical output)
text	-	(textual output)
acsi	-	(change input parameters)
end	-	(terminate execution)

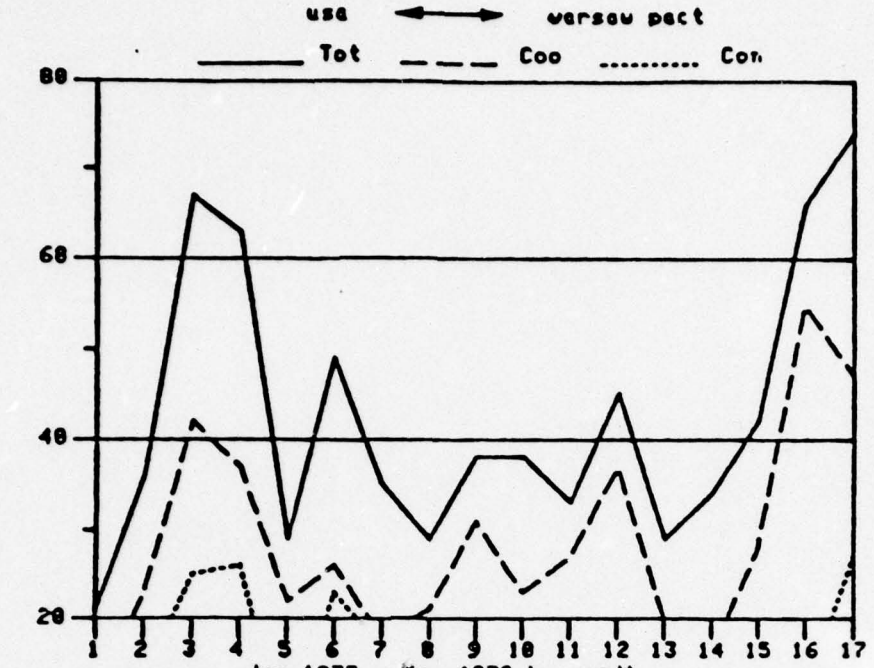
Any of these commands typed after the "%" will cause execution of the chosen function.

% plots

POLITICAL INDICATORS

	Total Activity	Coop Activity	Conflict Activity	Tension Level	Uncert Level
Raw Data	1	3	5	7	9
Z-Score	2	4	6	8	0

Do you want more than one plot per graph (y or n)y
You have these choices:
1 = graphs 1,3 + 5
2 = graphs 2,4 + 6
3 = graphs 7 + 9
4 = graphs 8 + 10
Please pick one :1



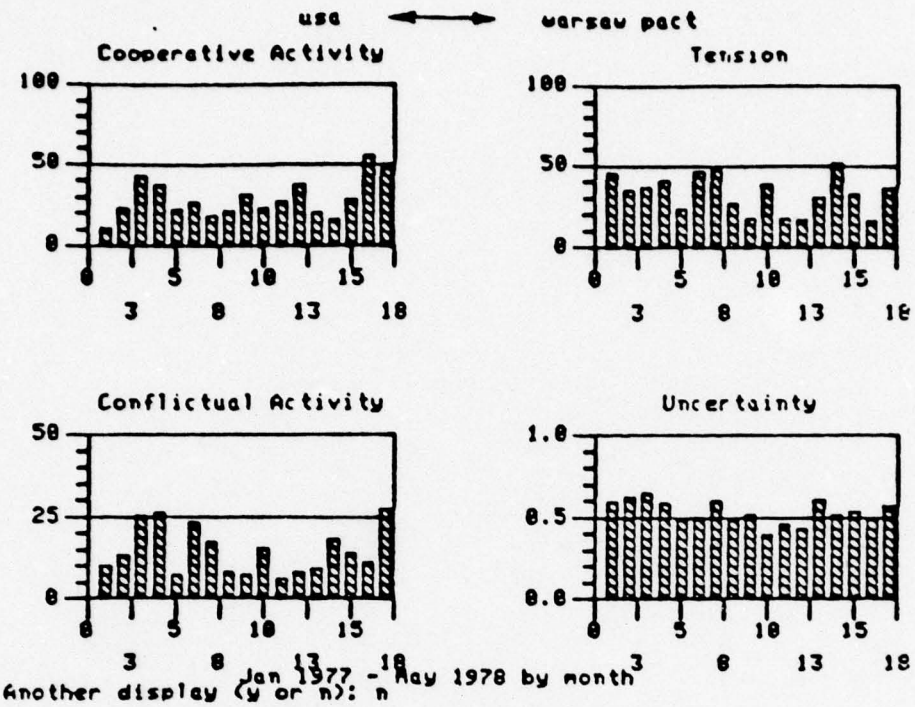
Another display (y or n): y

POLITICAL INDICATORS

	Total Activity	Coop Activity	Conflict Activity	Tension Level	Uncert Level
Raw Data	1	3	5	7	9
Z-Score	2	4	6	8	8

Do you want more than one plot per graph (y or n)n
Do you want graphs or bar-charts (g or b) s
How many charts do you want (1-6) 4

Please type in the 4 chart numbers you
would like displayed in the form (1,2,3 ... 6) 3,5,7,9



Jan 1977 - May 1978 by month

Another display (y or n): n

SYSTEM OPTIONS :

tables	-	(tabular output)
plots	-	(graphical output)
text	-	(textual output)
acsl	-	(change input parameters)
end	-	(terminate execution)

Any of these commands typed after the "%" will cause execution of the chosen function.

% tables

Monthly Activity
Jan, 1977 - May, 1978

usa <<<<<< Two-Way Flow >>>>>> war

Date	Total Activity number	z-score	prob	Cooperative Activity number	z-score	prob	Conflictual Activity number	z-score	prob
Jan 77	21	-0.37	0.10	11	-0.52	0.10	10	0.07	0.10
Feb 77	36	0.46	0.13	23	0.34	0.15	13	0.44	0.10
Mar 77	67	2.16	0.40	42	1.70	0.21	25	1.95	0.23
Apr 77	63	1.88	0.16	37	1.32	0.21	26	2.03	0.40
May 77	29	0.03	0.13	22	0.23	0.15	7	-0.34	0.10
Jun 77	49	1.10	0.16	26	0.52	0.15	23	1.62	0.23
Jul 77	35	0.34	0.13	18	-0.06	0.10	17	0.86	0.10
Aug 77	29	0.01	0.13	21	0.16	0.15	8	-0.24	0.10
Sep 77	38	0.58	0.13	31	0.88	0.15	7	-0.36	0.10
Oct 77	38	0.49	0.13	23	0.29	0.15	15	0.62	0.10
Nov 77	33	0.22	0.13	27	0.58	0.15	6	-0.49	0.10
Dec 77	45	0.87	0.13	37	1.31	0.21	8	-0.24	0.10
Jan 78	29	-0.81	0.10	20	0.06	0.15	9	-0.12	0.10
Feb 78	34	0.27	0.13	16	-0.23	0.10	18	1.01	0.23
Mar 78	42	0.71	0.13	28	0.65	0.15	14	0.50	0.16
Apr 78	66	2.03	0.40	55	2.62	0.21	11	0.12	0.10
May 78	74	2.42	0.40	47	1.96	0.21	27	2.13	0.40

Press RETURN to continue:

Monthly Tension and Uncertainty
Jan, 1977 - May, 1978

usa <<<<<< Two-Way Flow >>>>>> war

Date	Tension	Z-score	H-rel	Z-score
Jan 77	45.4	0.71	0.587	0.11
Feb 77	35.1	0.15	0.625	0.37
Mar 77	36.8	0.24	0.648	0.53
Apr 77	40.6	0.45	0.585	0.09
May 77	23.3	-0.50	0.488	-0.60
Jun 77	46.0	0.75	0.498	-0.53
Jul 77	47.2	0.81	0.594	0.16
Aug 77	26.6	-0.33	0.482	-0.64
Sep 77	17.9	-0.81	0.512	-0.43
Oct 77	38.4	0.33	0.393	-1.28
Nov 77	17.6	-0.83	0.457	-0.81
Dec 77	17.4	-0.84	0.430	-0.99
Jan 78	38.8	-0.13	0.603	0.27
Feb 78	51.4	1.08	0.515	-0.38
Mar 78	32.5	0.01	0.533	-0.24
Apr 78	16.4	-0.90	0.479	-0.64
May 78	36.0	0.21	0.567	0.02

Do you want event frequencies(y/n)? y

Monthly Cooperative Activity
Jan, 1977 - May, 1978

*** usa <<<<<< Two-Way Flow >>>>>> war ***

Date	YLD	CMNT	CNSL	APPR	PRMS	GRNT	REWD	AGRE	POST	PPOP
Jan 77	0	7	2	1	0	0	0	0	0	1
Feb 77	0	12	8	0	1	0	0	0	0	2
Mar 77	0	22	10	0	0	1	0	4	2	3
Apr 77	1	26	8	0	0	2	0	0	0	0
May 77	0	13	4	0	1	0	0	4	0	0
Jun 77	0	21	4	0	0	1	0	0	0	0
Jul 77	0	10	5	1	0	0	0	0	1	1
Aug 77	0	14	5	1	0	1	0	0	0	0
Sep 77	0	17	10	0	1	1	0	2	0	0
Oct 77	0	19	2	2	0	0	0	0	0	0
Nov 77	0	16	7	2	0	0	0	0	0	2
Dec 77	0	24	10	1	0	0	0	0	0	2
Jan 78	0	10	4	1	0	1	0	2	1	1
Feb 78	0	13	2	0	0	0	0	0	1	0
Mar 78	0	20	2	0	0	0	0	3	3	0
Apr 78	0	37	10	2	0	2	0	2	1	1
May 78	0	30	10	0	0	1	0	4	1	1

Press RETURN to continue:

Monthly Conflictual Activity
Jan, 1977 - May, 1978

*** usa <<<<<< Two-Way Flow >>>>>> war ***

Date	RJCT	ACUS	PROT	DENY	DMND	WARN	THRT	DEMO	RDUC	EXPL	SEIZ	FRCE
Jan 77	0	5	1	2	0	2	0	0	0	0	0	0
Feb 77	0	4	2	3	0	1	0	0	0	2	1	0
Mar 77	0	14	2	3	1	0	3	0	2	0	0	0
Apr 77	3	11	3	3	0	0	5	0	0	0	1	0
May 77	0	5	0	0	2	0	0	0	0	0	0	0
Jun 77	1	16	1	1	1	1	0	0	0	0	2	0
Jul 77	1	11	2	0	0	2	0	0	1	0	0	0
Aug 77	1	5	0	0	0	0	0	0	2	0	0	0
Sep 77	0	4	0	1	0	1	0	1	0	0	0	0
Oct 77	0	13	1	1	0	0	0	0	0	0	0	0
Nov 77	0	5	0	0	0	1	0	0	0	0	0	0
Dec 77	1	6	0	0	0	0	1	0	0	0	0	0
Jan 78	0	7	0	1	1	0	0	0	0	0	0	0
Feb 78	0	11	0	1	0	2	3	0	1	0	0	0
Mar 78	1	8	0	0	0	1	3	0	0	0	1	0
Apr 78	2	8	0	0	0	0	1	0	0	0	0	0
May 78	0	18	0	2	0	1	3	0	0	2	1	0

Press RETURN to continue:

```
                SYSTEM OPTIONS :

          tables    -    (tabular output)
          plots     -    (graphical output)
          text      -    (textual output)
          acsi      -    (change input parameters)
          end       -    (terminate execution)

     Any of these commands typed after the "%" will
     cause execution of the chosen function.


     % acsi
```

```
  *** EARLY WARNING AND MONITORING SYSTEM ACTIVATED ***


Are your actors:
    1. Countries
    2. JCS regions
    3. Both          1

Please select two countries(usa,usr):  usr,nat

Specify activity flow:
    0. one way (usr >>> nat)
    1. one way (usr <<< nat)
    2. two way (usr <-> nat)  2

Select time increment:
    1. monthly
    2. quarterly
    3. yearly                 1

Set time parameters(7501-7712):  7701-7805
```

AD-A057 389 DECISIONS AND DESIGNS INC MCLEAN VA F/G 15/3
THE EARLY WARNING AND MONITORING SYSTEM: A PROGRESS REPORT.(U)
JUL 78 J A DALY, T R DAVIES N00014-76-C-0712
UNCLASSIFIED PR-78-17-39 NL

3 OF 3
AD A057389

END
DATE FILMED
9-78
DDC

```
      ######  9.North Atlantic Treaty Org.  ######

          belgium                          (bel)
          canada                           (can)
          denmark                          (den)
          france                           (frn)
          germany/fed rep                  (gmu)
          greece                           (grc)
          iceland                          (ice)
          italy                            (ita)
          luxemburg                        (lux)
          netherlands                      (nth)
          norway                           (nor)
          portugal                         (por)
          turkey                           (tur)
          usa                              (usa)
          united kingdom                   (unk)

      ##################################################

Press RETURN to continue:
```

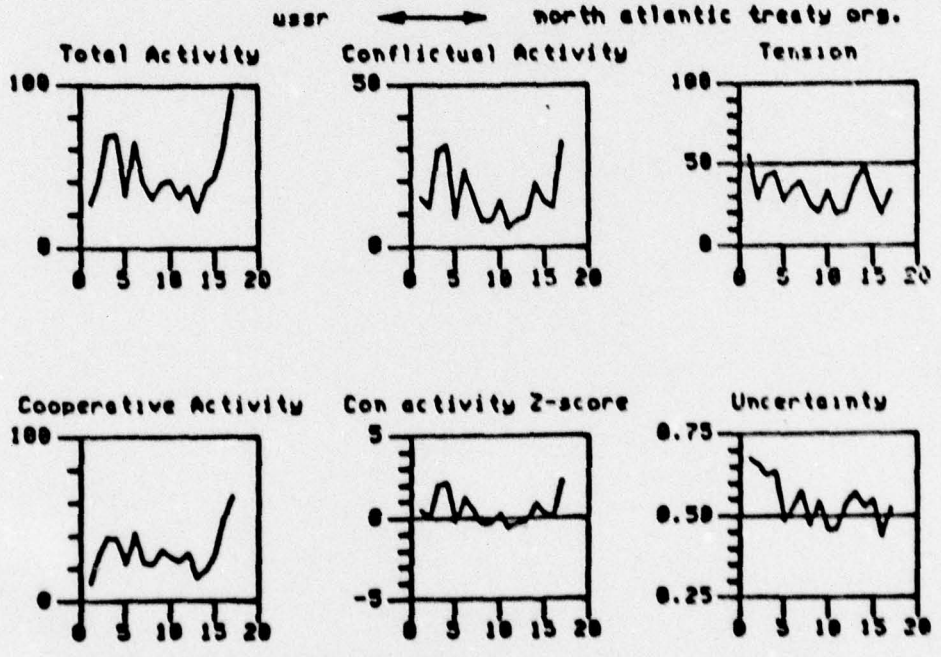
```
                    P R O C E S S I N G
                    C O M P L E T E D


Number of events found:    777
 Do you desire 30 day probablistic forecasts(y/n): y
```

Monthly Probability
Jan, 1977 - May, 1978

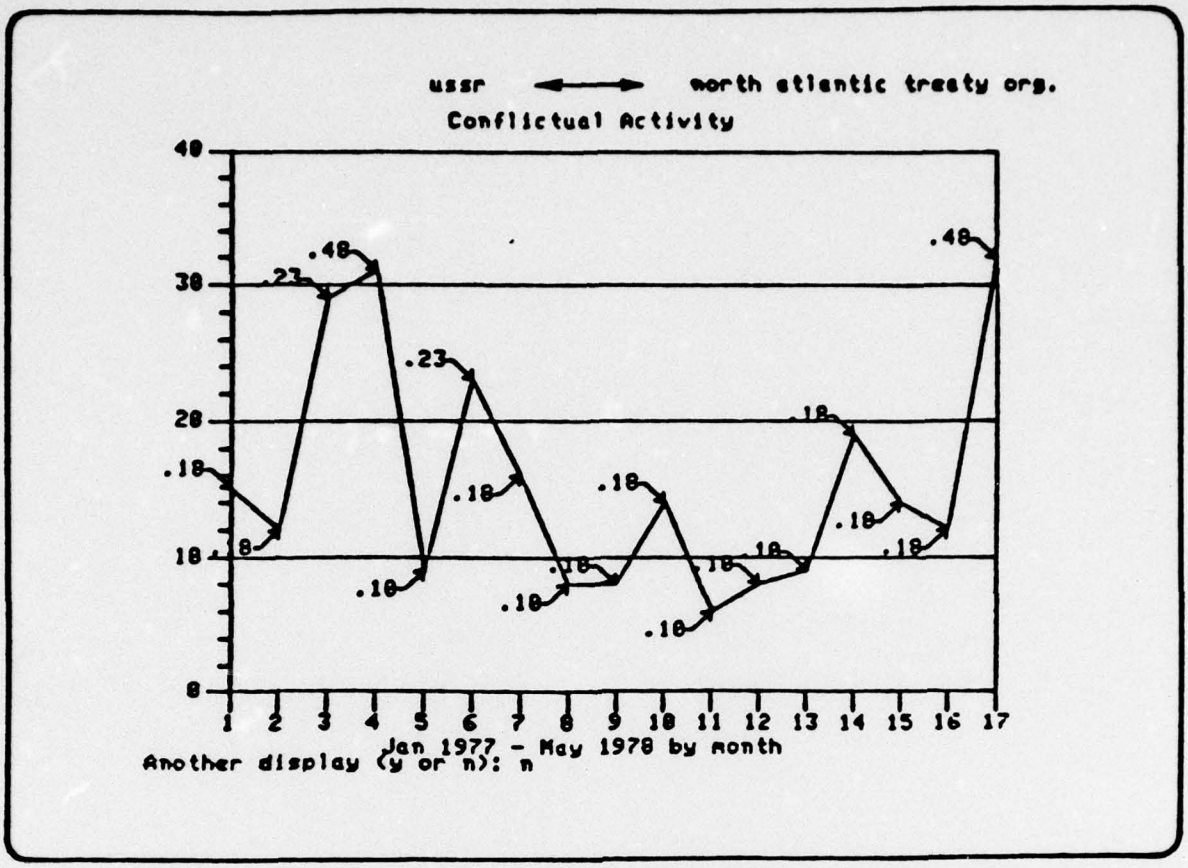
ssr usr ((())) nat ssr

Date	Probability
Jan 77	.10
Feb 77	.10
Mar 77	.23
Apr 77	.40
May 77	.10
Jun 77	.23
Jul 77	.10
Aug 77	.10
Sep 77	.10
Oct 77	.10
Nov 77	.10
Dec 77	.10
Jan 78	.10
Feb 78	.10
Mar 78	.10
Apr 78	.10
May 78	.40

Press RETURN to continue:



Another display (y or n): y



Monthly Activity
Jan, 1977 - May, 1978

*** usr <<<<<< Two-Way Flow >>>>>> nat ***

Date	Total Activity number	z-score	prob	Cooperative Activity number	z-score	prob	Conflictual Activity number	z-score	prob
Jan 77	26	-0.34	0.10	11	-0.71	0.10	15	0.43	0.10
Feb 77	41	0.36	0.13	29	0.42	0.15	12	0.10	0.10
Mar 77	60	1.62	0.16	39	1.05	0.21	29	1.95	0.23
Apr 77	69	1.64	0.16	38	0.98	0.15	31	2.12	0.45
May 77	32	-0.10	0.10	23	0.02	0.15	9	-0.26	0.10
Jun 77	64	1.39	0.16	41	1.16	0.21	23	1.23	0.23
Jul 77	40	0.26	0.13	24	0.08	0.15	16	0.47	0.10
Aug 77	30	-0.20	0.10	22	-0.05	0.10	8	-0.38	0.10
Sep 77	39	0.22	0.13	31	0.52	0.15	8	-0.38	0.10
Oct 77	41	0.31	0.13	27	0.26	0.15	14	0.26	0.10
Nov 77	30	-0.21	0.10	24	0.07	0.15	6	-0.60	0.10
Dec 77	37	0.12	0.13	29	0.39	0.15	8	-0.38	0.10
Jan 78	23	-0.54	0.10	14	-0.58	0.10	9	-0.27	0.10
Feb 78	30	0.17	0.13	19	-0.25	0.10	19	0.82	0.15
Mar 78	42	0.36	0.13	28	0.33	0.15	14	0.27	0.10
Apr 78	61	1.27	0.16	49	1.71	0.21	12	0.05	0.10
May 78	96	2.93	0.40	64	2.65	0.21	32	2.25	0.40

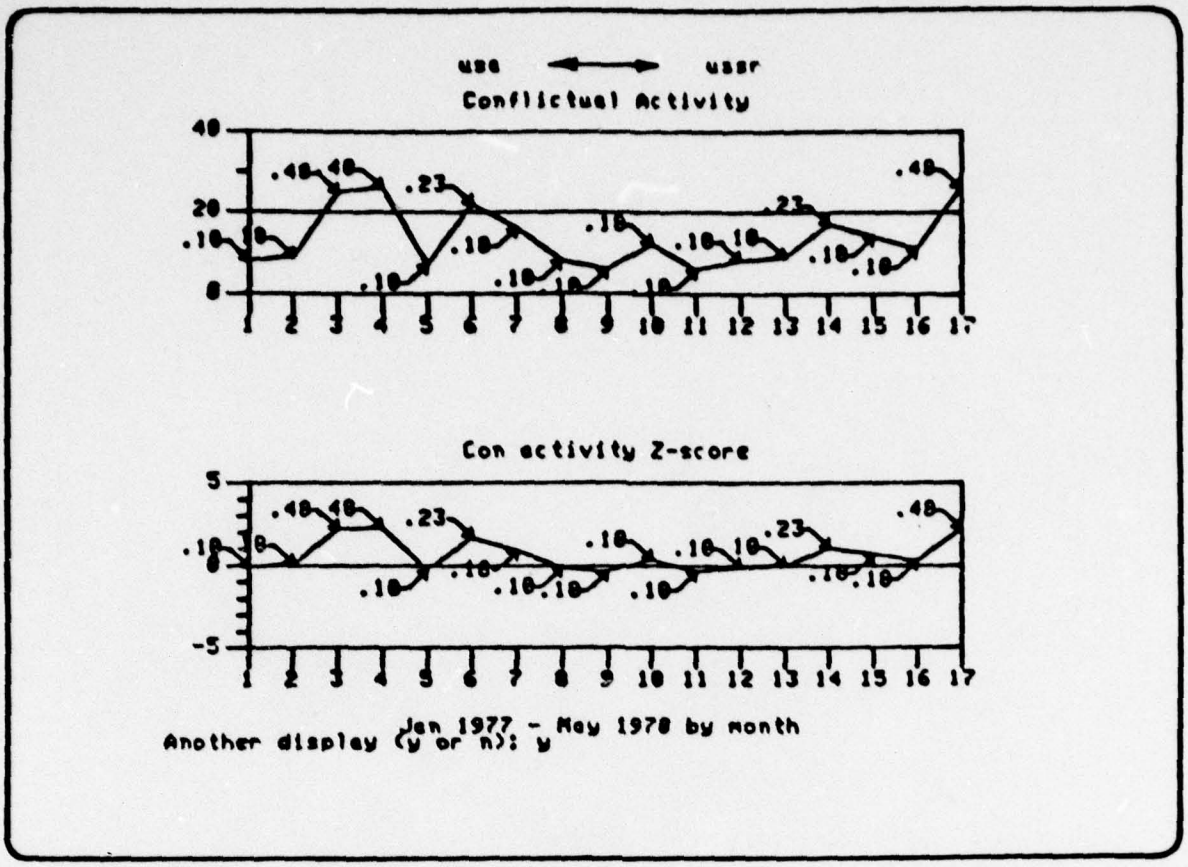
Press RETURN to continue:

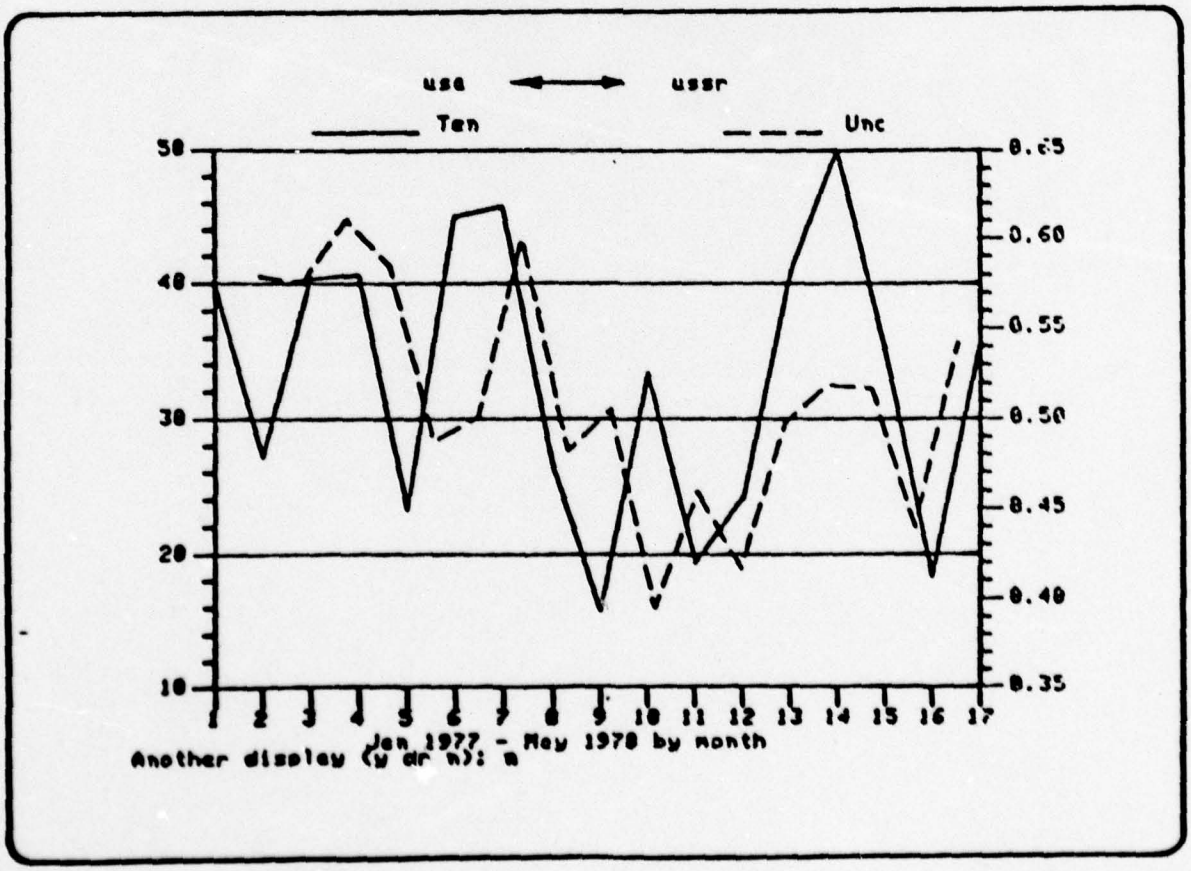
```
                Monthly   Tension and Uncertainty
                  Jan, 1977 - May, 1978

        ### usr <<<<<< Two-Way Flow >>>>>> mat ###

   Date    Tension Z-score   M-rel Z-score

 Jan 77      55.5     1.41   0.675    0.65
 Feb 77      28.6    -0.17   0.657    0.49
 Mar 77      42.0     0.61   0.623    0.20
 Apr 77      44.3     0.74   0.637    0.32
 May 77      27.2    -0.26   0.484   -1.00
 Jun 77      35.4     0.22   0.529   -0.60
 Jul 77      39.0     0.43   0.576   -0.19
 Aug 77      25.8    -0.36   0.474   -1.00
 Sep 77      20.0    -0.70   0.544   -0.46
 Oct 77      33.3     0.10   0.456   -1.22
 Nov 77      19.3    -0.74   0.459   -1.18
 Dec 77      21.0    -0.63   0.535   -0.51
 Jan 78      37.4     0.36   0.569   -0.21
 Feb 78      48.7     1.04   0.523   -0.61
 Mar 78      32.5     0.05   0.547   -0.39
 Apr 78      19.3    -0.75   0.438   -1.36
 May 78      33.0     0.09   0.524   -0.59

Do you want event frequencies(y/n)?  n
```

```
        ### EARLY WARNING AND MONITORING SYSTEM ACTIVATED ###


Are your actors:
    1. Countries
    2. JCS regions
    3. Both          1

Please select two countries(usa,usr):  usa,usr

Specify activity flow:
    0. one way (usa >>> usr)
    1. one way (usa <<< usr)
    2. two way (usa <-> usr)  2

Select time increment:
    1. monthly
    2. quarterly
    3. yearly                 1

Set time parameters(7501-7712):  7701-7805
```

```
P R O C E S S I N G
C O M P L E T E D


Number of events found:    673
 Do you desire 30 day probablistic forecasts(y/n): y
```

```
  Monthly    Probability
Jan, 1977 - May, 1978

$$$ use  <<<>>>  usr $$$

Date          Probability

Jan 77              .10
Feb 77              .18
Mar 77              .48
Apr 77              .48
May 77              .10
Jun 77              .23
Jul 77              .18
Aug 77              .10
Sep 77              .10
Oct 77              .18
Nov 77              .10
Dec 77              .10
Jan 78              .10
Feb 78              .23
Mar 78              .18
Apr 78              .18
May 78              .48

Press RETURN to continue:
```


usa ⟷ ussr
Conflictual Activity
40
20
0
.48 .48 .23 .18 .18 .18 .18 .18 .23 .18 .18 .48
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Con activity Z-score
5
0
-5
.48 .48 .23 .18 .18 .18 .18 .18 .23 .18 .18 .48
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Jan 1977 - May 1978 by month
Another display (y or n): y


usa ⟷ ussr
Ten
Unc
50
40
30
20
10
0.65
0.60
0.55
0.50
0.45
0.40
0.35
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Jan 1977 - May 1978 by month
Another display (y or n): n

Monthly Activity
Jan, 1977 - May, 1978

$$$ use <<<<<< Two-Way Flow >>>>>> usr $$$

Date	Total Activity number	z-score	prob	Cooperative Activity number	z-score	prob	Conflictual Activity number	z-score	prob
Jan 77	19	-0.38	0.10	11	-0.37	0.10	8	-0.08	0.10
Feb 77	32	0.46	0.13	23	0.59	0.15	9	0.06	0.10
Mar 77	61	2.18	0.40	36	1.62	0.21	25	2.18	0.40
Apr 77	63	2.23	0.40	37	1.67	0.21	26	2.25	0.40
May 77	29	0.23	0.13	22	0.47	0.15	7	-0.25	0.10
Jun 77	48	1.32	0.16	26	0.78	0.15	22	1.68	0.23
Jul 77	34	0.58	0.13	18	0.14	0.15	16	0.89	0.19
Aug 77	29	0.21	0.13	21	0.38	0.15	8	-0.14	0.10
Sep 77	37	0.67	0.13	31	1.17	0.21	6	-0.40	0.10
Oct 77	35	0.55	0.13	23	0.52	0.15	12	0.38	0.10
Nov 77	30	0.26	0.13	24	0.60	0.15	6	-0.40	0.10
Dec 77	32	0.37	0.13	24	0.60	0.15	8	-0.14	0.10
Jan 78	21	-0.27	0.10	12	-0.37	0.10	9	-0.01	0.10
Feb 78	33	0.43	0.13	16	-0.05	0.10	17	1.04	0.23
Mar 78	39	0.78	0.13	25	0.68	0.15	14	0.64	0.15
Apr 78	59	1.96	0.16	48	2.54	0.21	11	0.24	0.10
May 78	72	2.67	0.40	46	2.30	0.21	26	2.22	0.40

Press RETURN to continue:

Monthly Tension and Uncertainty
Jan, 1977 - May, 1978

$$$ use <<<<<< Two-Way Flow >>>>>> usr $$$

Date	Tension	Z-score	H-rel	Z-score
Jan 77	39.9	0.38	0.579	0.21
Feb 77	27.2	-0.31	0.576	0.19
Mar 77	40.3	0.40	0.611	0.44
Apr 77	40.6	0.42	0.585	0.25
May 77	23.3	-0.54	0.488	-0.44
Jun 77	44.9	0.66	0.501	-0.35
Jul 77	45.7	0.70	0.600	0.37
Aug 77	26.6	-0.37	0.482	-0.49
Sep 77	15.8	-0.97	0.505	-0.32
Oct 77	33.3	0.02	0.395	-1.12
Nov 77	19.3	-0.77	0.459	-0.64
Dec 77	24.2	-0.49	0.417	-0.94
Jan 78	40.8	0.45	0.497	-0.35
Feb 78	58.8	0.97	0.519	-0.19
Mar 78	35.8	0.11	0.517	-0.20
Apr 78	18.3	-0.84	0.439	-0.78
May 78	35.6	0.15	0.542	-0.01

Do you want event frequencies(y/n)? n

```
                SYSTEM OPTIONS :

          tables    -    (tabular output)
          plots     -    (graphical output)
          text      -    (textual output)
          acsi      -    (change input parameters)
          end       -    (terminate execution)

     Any of these commands typed after the "%" will
     cause execution of the chosen function.


     % text
```

```
     ****************** Event Types **********************

     Cooperative Events:

        01 Yield (YLD)              06 Grant (GRNT)
        02 Comment (CMNT)           07 Reward (REWD)
        03 Consult (CNSL)           08 Agree (AGRE)
        04 Approve (APPR)           09 Request (POST)
        05 Promise (PRMS)           10 Propose (PROP)

     Conflictual Events:

        11 Reject (RJCT)            17 Threat (THRT)
        12 Accuse (ACUS)            18 Demonstrate (DEMO)
        13 Protest (PROT)           19 Reduce (RDUC)
        14 Deny (DENY)              20 Expel (EXPL)
        15 Demand (DMND)            21 Seize (SEIZ)
        16 Warn (WARN)              22 Force (FRCE)

     Please Specify Event Types:

        1. All cooperative events
        2. All conflictual events
        3. All events
        4. Combination              3

     Do you want to perform a keyword search for these event types(Y-N)?
y

     Enter Keyword expression or press RETURN for help:
arms talks,salt

     Specify dates (6601-6604): 7801-7805
     Page full. . . press RETURN to continue
```

```
##################################TEXT##################################
actors . . . . . : usa,usr
flow   . . . . . : usa <<< two-way flow >>> usr
time parameters. . . . : 7801-7805
event types. . . . . : all events
keyword expression . . : ARMS TALKS,SALT
########################################################################
780211365121  2  0
the usr blames the lack of progress in the usa - usr
strategic arms talks on opposition
in congress, the pentagon and the military industrial
complex usr

7803 3  2 23365  0
usa prs carter says that the strategic arms talks under
way in geneva have taken more time than he had expected and
that "12 highly technical issues" still stand in the way of
agreement between the usa and usr

780410  2 25365  0
usa sst vance says that "i think the negotiation of a
salt agreement is central to the security of the usa
and soviet union and the peace of the world and should
be negotiated on its own feet and we will do that" usr

7805 4  2 23365  0
usa prs carter says he does not think the usa and the soviet
union have finally agreed on an overall ceiling for missiles
and bombers at the strategic arms talks usr

      Page full. . . press RETURN to continue
```

```
##################################TEXT##################################
actors . . . . . : usa,usr
flow   . . . . . : usa <<< two-way flow >>> usr
time parameters. . . . : 7801-7805
event types. . . . . : all events
keyword expression . . : ARMS TALKS,SALT
########################################################################
780518  2 23365  0
usa dos rep tom reston says regarding
whether the usr orlov trial would have any effect on the
arms talks that the strategic arms limitation treaty was
designed "to enhance the security of the citizens of the
usa" usr

780527  2 23365  0
according to usa officials national security adviser
brzezinski and his aides gave china a detailed
briefing on the status of usr-usa strategic arms talks and
explained some secret white house memoranda on usa security
goals chn usr

      Do you want to perform another keyword search for the event types(Y/
N)? n

      Do you want to look at more text (Y/N)? n
```

```
$$$ EARLY WARNING AND MONITORING SYSTEM ACTIVATED $$$


Are your actors:
    1. Countries
    2. JCS regions
    3. Both          1

Please select two countries(usa,usr):  usr,chn

Specify activity flow:
    0. one way (usr >>> chn)
    1. one way (usr <<< chn)
    2. two way (usr <-> chn)  2

Select time increment:
    1. monthly
    2. quarterly
    3. yearly                 1

Set time parameters(7501-7712):  7701-7805
```

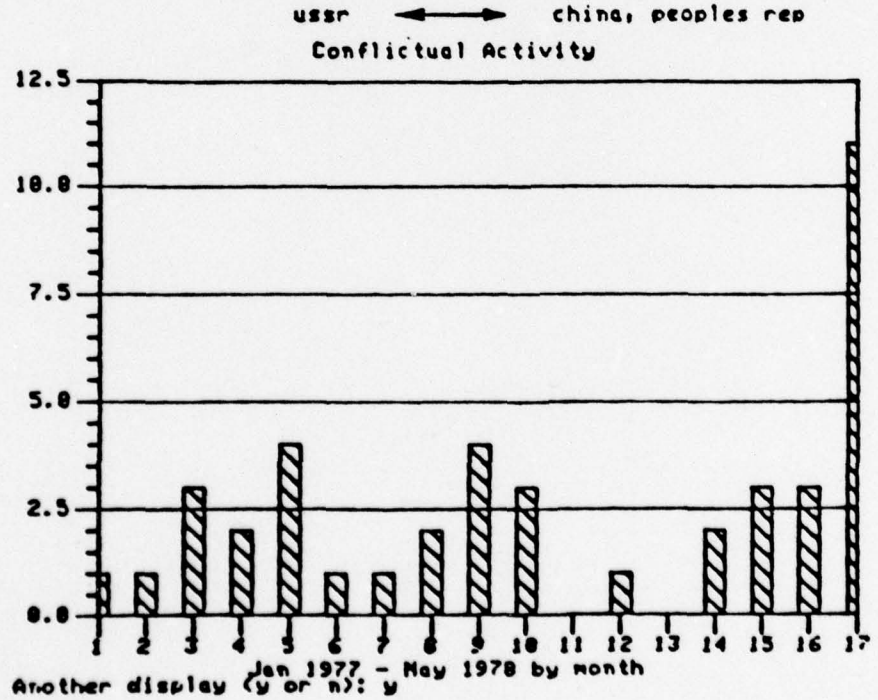
```
P R O C E S S I N G
C O M P L E T E D


Number of events found:     64
 Do you desire 30 day probablistic forecasts(y/n): y
```

Monthly Probability
Jan, 1977 - May, 1978

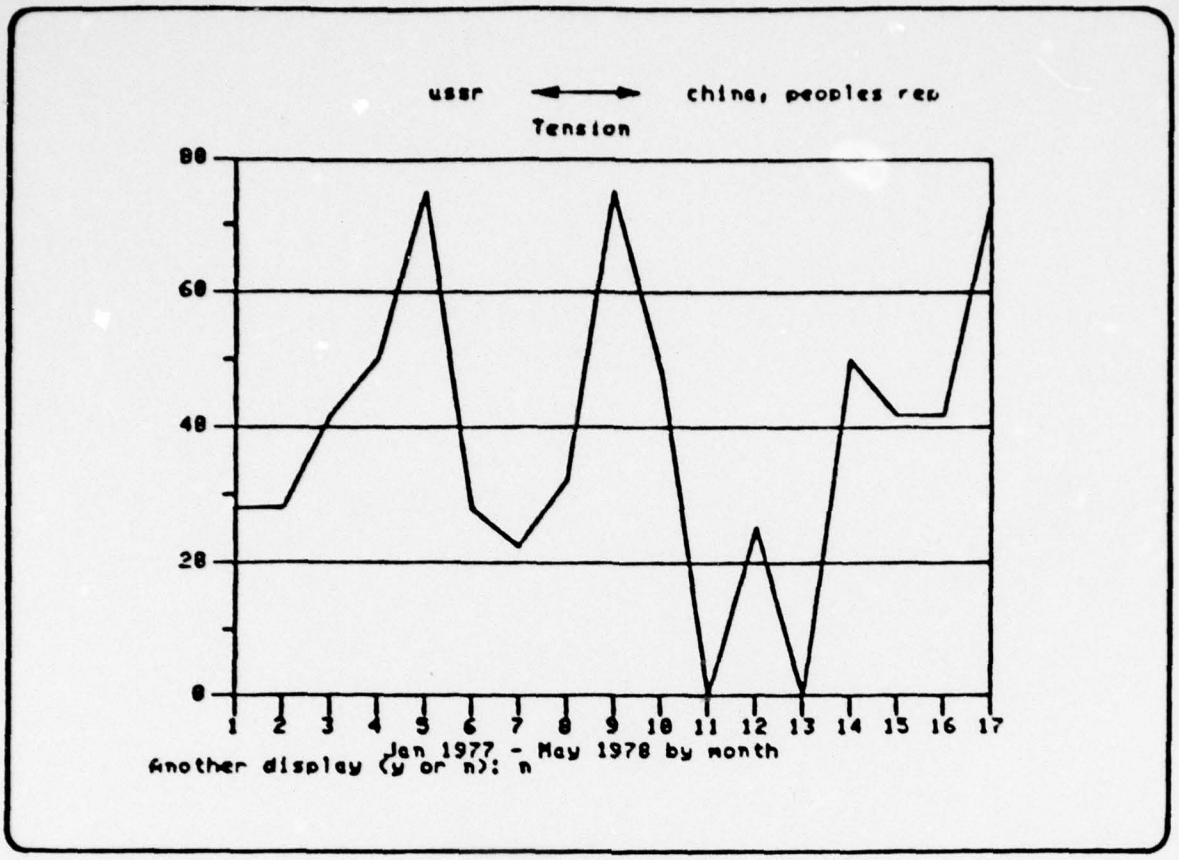
usr <<<>>> chn

Date	Probability
Jan 77	.10
Feb 77	.10
Mar 77	.10
Apr 77	.10
May 77	.10
Jun 77	.10
Jul 77	.10
Aug 77	.10
Sep 77	.10
Oct 77	.10
Nov 77	.10
Dec 77	.10
Jan 78	.10
Feb 78	.10
Mar 78	.10
Apr 78	.10
May 78	.23

Press RETURN to continue:



Another display (y or n): y



Monthly Activity
Jan, 1977 - May, 1978

usr <<<<<< Two-Way Flow >>>>>> chn

Date	Total Activity number	z-score	prob	Cooperative Activity number	z-score	prob	Conflictual Activity number	z-score	prob
Jan 77	1	-0.60	0.10	0	-0.60	0.10	1	-0.48	0.10
Feb 77	1	-0.59	0.10	0	-0.60	0.10	1	-0.46	0.10
Mar 77	6	0.85	0.13	3	0.79	0.15	3	-0.19	0.10
Apr 77	2	-0.47	0.10	0	-0.60	0.10	2	-0.33	0.10
May 77	4	-0.21	0.10	0	-0.60	0.10	4	-0.04	0.10
Jun 77	1	-0.59	0.10	0	-0.60	0.10	1	-0.47	0.10
Jul 77	3	-0.33	0.10	2	0.34	0.15	1	-0.47	0.10
Aug 77	5	-0.07	0.10	3	0.81	0.15	2	-0.32	0.10
Sep 77	4	-0.20	0.10	0	-0.61	0.10	4	-0.03	0.10
Oct 77	5	-0.07	0.10	2	0.34	0.15	3	-0.18	0.10
Nov 77	2	-0.46	0.10	2	0.34	0.15	0	-0.62	0.10
Dec 77	2	-0.46	0.10	1	-0.14	0.10	1	-0.46	0.10
Jan 78	0	-0.72	0.10	0	-0.62	0.10	0	-0.61	0.10
Feb 78	2	-0.45	0.10	0	-0.61	0.10	2	-0.31	0.10
Mar 78	6	0.89	0.13	3	0.83	0.15	3	-0.16	0.10
Apr 78	6	0.89	0.13	3	0.83	0.15	3	-0.16	0.10
May 78	14	1.17	0.16	3	0.82	0.15	11	1.04	0.27

Press RETURN to continue:

Monthly Tension and Uncertainty
Jan, 1977 - May, 1978

usr <<<<<< Two-Way Flow >>>>>> chn

Date	Tension	Z-score	M-rel	Z-score
Jan 77	28.0	-0.64	0.000	-0.92
Feb 77	28.0	-0.64	0.000	-0.91
Mar 77	41.7	-0.15	0.224	0.26
Apr 77	50.0	0.15	0.000	-0.91
May 77	75.0	1.04	0.000	-0.90
Jun 77	28.0	-0.65	0.000	-0.89
Jul 77	22.2	-0.85	0.206	0.19
Aug 77	32.0	-0.49	0.341	0.90
Sep 77	75.0	1.06	0.336	0.87
Oct 77	48.0	0.08	0.218	0.24
Nov 77	0.0	-1.66	0.224	0.27
Dec 77	25.0	-0.73	0.224	0.27
Jan 78	0.0	-1.62	0.000	-0.93
Feb 78	50.0	0.18	0.000	-0.92
Mar 78	41.7	-0.12	0.327	0.83
Apr 78	41.7	-0.12	0.430	1.37
May 78	73.0	1.01	0.630	2.42

Do you want event frequencies(y/n)? n

TEXT

Event Types

Cooperative Events:

01 Yield (YLD)	06 Grant (GRNT)
02 Comment (CMNT)	07 Reward (REWD)
03 Consult (CNSL)	08 Agree (AGRE)
04 Approve (APPR)	09 Request (ROST)
05 Promise (PRMS)	10 Propose (PROP)

Conflictual Events:

11 Reject (RJCT)	17 Threat (THRT)
12 Accuse (ACUS)	18 Demonstrate (DEMO)
13 Protest (PROT)	19 Reduce (RDUC)
14 Deny (DENY)	20 Expel (EXPL)
15 Demand (DMND)	21 Seize (SEIZ)
16 Warn (WARN)	22 Force (FRCE)

Please Specify Event Types:
1. All cooperative events
2. All conflictual events
3. All events
4. Combination 2

Specify dates: (e.g. 6601-6604) 7805-7805

date: 780511 actor: 710 event: 121 target: 365 arena: 0
china charges that soviet union soldiers using a
helicopter and military boats cross the border
and shoot and wound some chinese chn usr

date: 780511 actor: 710 event: 223 target: 365 arena: 0
china officials report that soviet union soldiers
cross the border and shoot and wound some chinese
chn usr

date: 780511 actor: 710 event: 132 target: 365 arena: 0
the china press agency, hsinhua, says that chn deputy
fm yu chan hands a note of protest to amb vasily
tolstikov in peking on the incident of usr soldiers
crossing the border and wounding
some chinese usr chn

date: 780511 actor: 710 event: 150 target: 365 arena: 0
china leader hua kuo-feng reiterates demands that the
soviet union withdraw its troops from the frontier region,
agree to maintain the status quo on the border and avoid
armed clashes chn usr

Page full...press RETURN to continue

date: 780511 actor: 365 event: 223 target: 710 arena: 0
china officials report that soviet union soldiers cross the
border and wound some chn soldiers usr

date: 780512 actor: 365 event: 142 target: 710 arena: 0
the soviet union conveys regrets to china over what it
says was an accidental crossing by a usr patrol into chn
territory but denies peking's charges that usr men shot,
beat and kicked chinese citizens usr chn

date: 780513 actor: 710 event: 121 target: 365 arena: 0
the china govt says that it is not satisfied with
the soviet union's explanation of why usr troops, boats
and a helicopter crossed into manchuria earlier this week
chn usr

date: 780517 actor: 710 event: 150 target: 365 arena: 0
china deputy foreign minister yu chan reads a note to
soviet union amb tolstikov that says the usr explanation
of a border incident that wounded several chn soldiers is not
acceptable and demands a formal reply with what he calls
an honest account chn usr

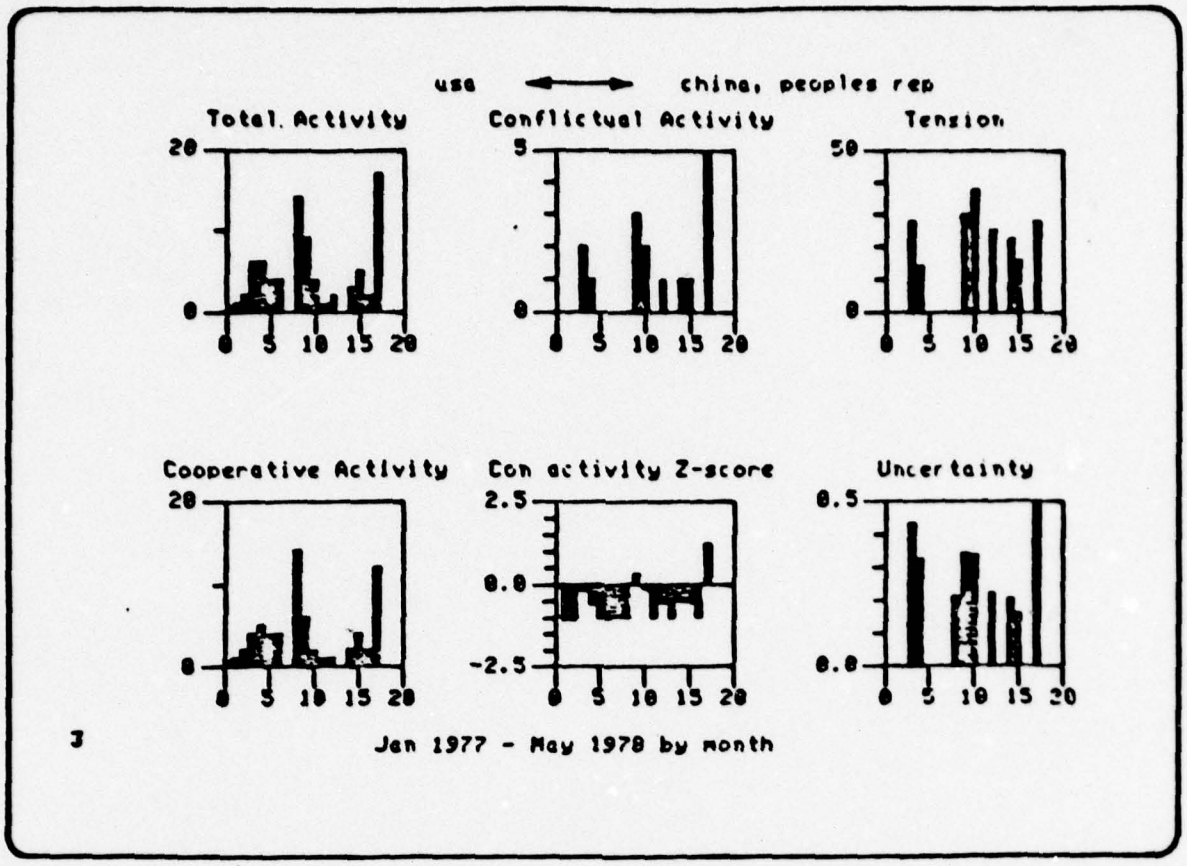
Page full...press RETURN to continue

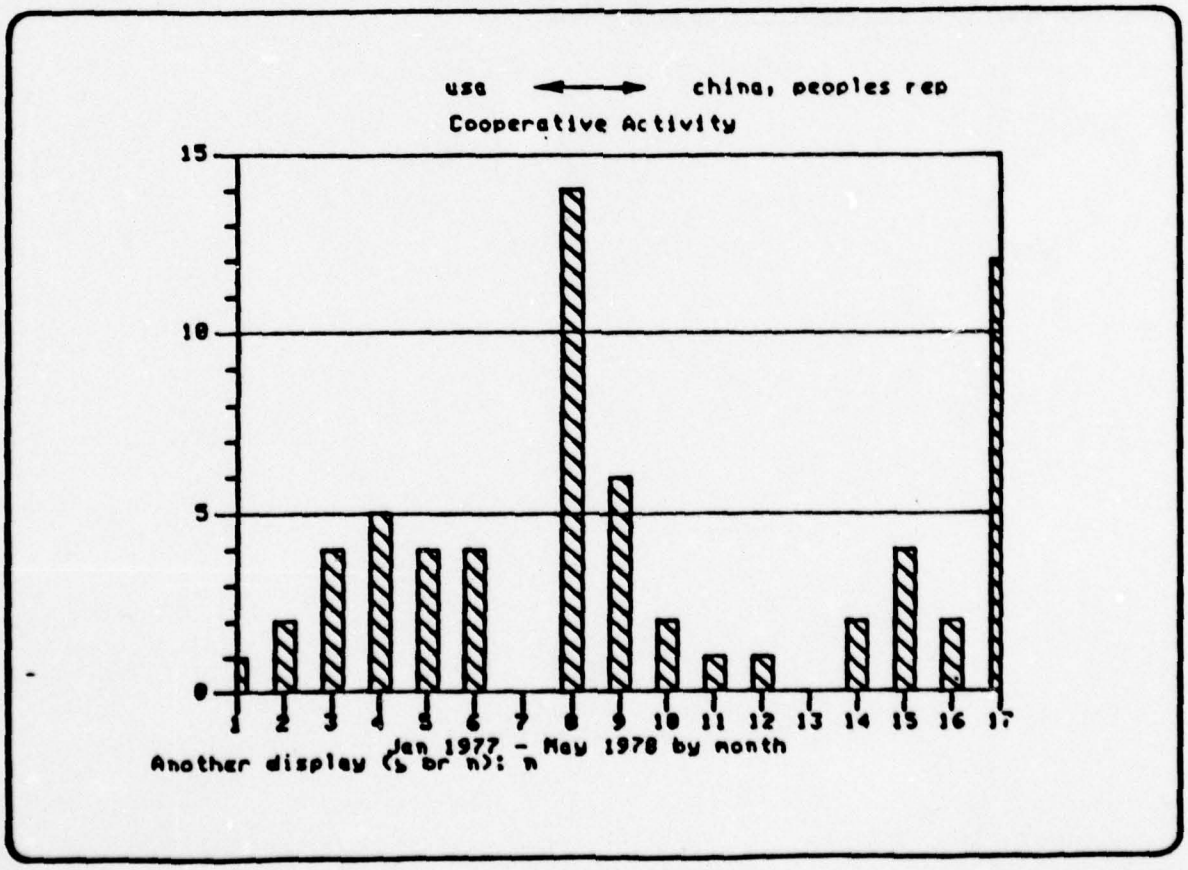
```
date: 780529  actor: 710  event: 121  target: 365  arena:   0
    china fm huang hua speaks at the uno special session and
    calls the soviet union the "most dangerous source of a new
    world war" chn usr

date: 780529  actor: 710  event: 121  target: 365  arena:   0
    china fm huang hua speaks at the uno special session on
    disarmament and accuses the soviet union of preaching
    disarmament while expanding and perfecting their
    weaponry chn usr

date: 780529  actor: 365  event: 181  target: 710  arena:   0
    soviet union delegate oleg troyanovsky to the uno walks
    out of china fm huang hua's speech while he says "the usr
    is increasing its military threat to western europe,
    striving to expand its influence in the middle east and
    carrying out a series of military adventures in africa" chn

      Do you want to look at more text (Y/N):n
```

```
    888 EARLY WARNING AND MONITORING SYSTEM ACTIVATED 888


  Are your actors:
      1. Countries
      2. JCS regions
      3. Both          1

  Please select two countries(usa,usr):  usa.chn

  Specify activity flow:
      0. one way (usa >>> chn)
      1. one way (usa <<< chn)
      2. two way (usa <-> chn)  2

  Select time increment:
      1. monthly
      2. quarterly
      3. yearly                    1

  Set time parameters(7501-7712):  7701-7805
```

```
P R O C E S S I N G
C O M P L E T E D


Number of events found:      00
 Do you desire 30 day probablistic forecasts(y/n): y
```

```
  Monthly    Probability
Jan, 1977 - May, 1978

$$$ use  <<<>>>  chn $$$

Date          Probability

Jan 77              .10
Feb 77              .10
Mar 77              .10
Apr 77              .10
May 77              .10
Jun 77              .10
Jul 77              .10
Aug 77              .10
Sep 77              .10
Oct 77              .10
Nov 77              .10
Dec 77              .10
Jan 78              .10
Feb 78              .10
Mar 78              .10
Apr 78              .10
May 78              .23

Press RETURN to continue:
```


usa ⟷ china, peoples rep
Total Activity
Conflictual Activity
Tension
Cooperative Activity
Con activity Z-score
Uncertainty
Jan 1977 - May 1978 by month


usa ⟷ china, peoples rep
Cooperative Activity
Jan 1977 - May 1978 by month
Another display (b or n): n

Monthly Activity
Jan, 1977 - May, 1978

use <<<<<< Two-Way Flow >>>>>> chn

Date	Total Activity number	z-score	prob	Cooperative Activity number	z-score	prob	Conflictual Activity number	z-score	prob
Jan 77	1	-0.83	0.10	1	-0.48	0.10	0	-1.04	0.10
Feb 77	2	-0.65	0.10	2	-0.28	0.10	0	-1.03	0.10
Mar 77	6	0.03	0.13	4	0.12	0.15	2	-0.16	0.10
Apr 77	6	0.03	0.13	5	0.32	0.15	1	-0.60	0.10
May 77	4	-0.31	0.10	4	0.12	0.15	0	-1.02	0.10
Jun 77	4	-0.31	0.10	4	0.11	0.15	0	-1.01	0.10
Jul 77	0	-1.00	0.10	0	-0.69	0.10	0	-1.00	0.10
Aug 77	14	1.43	0.16	14	2.14	0.21	0	-0.99	0.10
Sep 77	9	0.55	0.13	6	0.50	0.15	3	0.29	0.10
Oct 77	4	-0.32	0.10	2	-0.38	0.10	2	-0.13	0.10
Nov 77	1	-0.83	0.10	1	-0.58	0.10	0	-0.99	0.10
Dec 77	2	-0.65	0.10	1	-0.50	0.10	1	-0.55	0.10
Jan 78	0	-1.00	0.10	0	-0.70	0.10	0	-0.98	0.10
Feb 78	3	-0.47	0.10	2	-0.29	0.10	1	-0.54	0.10
Mar 78	5	-0.12	0.10	4	0.12	0.15	1	-0.54	0.10
Apr 78	2	-0.64	0.10	2	-0.29	0.10	0	-0.97	0.10
May 78	17	2.00	0.16	12	1.75	0.21	5	1.21	0.23

Press RETURN to continue:

Monthly Tension and Uncertainty
Jan, 1977 - May, 1978

use <<<<<< Two-Way Flow >>>>>> chn

Date	Tension	Z-score	H-rel	Z-score
Jan 77	0.0	-1.18	0.000	-1.23
Feb 77	0.0	-1.16	0.000	-1.21
Mar 77	27.8	-0.12	0.430	0.95
Apr 77	13.9	-0.64	0.327	0.43
May 77	0.0	-1.15	0.000	-1.22
Jun 77	0.0	-1.14	0.000	-1.20
Jul 77	0.0	-1.13	0.000	-1.19
Aug 77	0.0	-1.11	0.212	-0.11
Sep 77	29.6	0.00	0.343	0.54
Oct 77	37.5	0.30	0.336	0.51
Nov 77	0.0	-1.11	0.000	-1.20
Dec 77	25.0	-0.16	0.224	-0.05
Jan 78	0.0	-1.11	0.000	-1.19
Feb 78	22.2	-0.26	0.206	-0.13
Mar 78	16.0	-0.49	0.162	-0.36
Apr 78	0.0	-1.18	0.000	-1.18
May 78	27.7	-0.03	0.488	1.31

Do you want event frequencies(y/n)? n

```
$$$$$$$$$$ TEXT $$$$$$$$$$

Event Types

Cooperative Events:
   01 Yield (YLD)              06 Grant (GRNT)
   02 Comment (CMNT)           07 Reward (REWD)
   03 Consult (CNSL)           08 Agree (AGRE)
   04 Approve (APPR)           09 Request (RQST)
   05 Promise (PRMS)           10 Propose (PROP)

Conflictual Events:
   11 Reject (RJCT)            17 Threat (THRT)
   12 Accuse (ACUS)            18 Demonstrate (DEMO)
   13 Protest (PROT)           19 Reduce (RDUC)
   14 Deny (DENY)              20 Expel (EXPL)
   15 Demand (DMND)            21 Seize (SEIZ)
   16 Warn (WARN)              22 Force (FRCE)

Please Specify Event Types:
   1. All cooperative events
   2. All conflictual events
   3. All events
   4. Combination              4

Enter event types: (e.g. 01,02,21..) 12,15,16

Specify dates: (e.g. 6601-6604) 7805-7805
```

```
date: 7805 5  actor: 710  event: 158  target:   2  arena:   0
    china leader hua kuo-feng calls for the withdrawal of
    usa troops from south korea and the dissolution of the
    uno command chn kos

date: 7805 7  actor: 710  event: 121  target:   2  arena:   0
    china party chairman hua kuo-feng says chn would never
    recognize south korea and accuses the usa of pursuing
    a policy of aggression in korea kos

date: 780529  actor: 710  event: 121  target:   2  arena:   0
    china fm huang hua speaks at the uno special session on
    disarmament and accuses the usa of preaching disarmament
    while expanding and perfecting their weaponry chn

date: 780529  actor: 710  event: 160  target:   2  arena:   0
    china fm huang hua speaks at the uno special session on
    disarmament and calls the soviet union the "most dangerous
    source of a new world war" and warns washington that a
    policy of appeasing the usr will only bring war closer
    chn usa

      Do you want to look at more text (Y/N):n
```

```
### EARLY WARNING AND MONITORING SYSTEM ACTIVATED ###


Are your actors:
    1. Countries
    2. JCS regions
    3. Both          3
```

```
                    ### REGIONAL OPTIONS ###

JCS REGIONS$

1.  North America (NAM)
2.  Central and South America (CSA)
3.  Western Europe--Mediterannean Atlantic (WEM)
4.  Eastern Europe--Soviet Union (ESU)
5.  Middle East and North Africa (MEA)
6.  East Asia and Pacific (EAP)
7.  South Asia and Sub-Saharan Africa (SAS)
8.  World (WOR)
9.  Special Purpose Region (SPR)

Do you want a list of actors in a region(y/n)?n

Select a country and a region(usa,mea):  isr,spr

Specify activity flow:
    0. one way (isr >>> spr)
    1. one way (isr <<< spr)
    2. two way (isr <-> spr)  2

Select time increment:
    1. monthly
    2. quarterly
    3. yearly                 1

Set time parameters(7501-7712):  7701-7805
```

```
******* 9. Special Purpose Region *******

    egypt                                (uar)
    syria                                (syr)
    jordan                               (jor)

**********************************************

Press RETURN to continue:
```

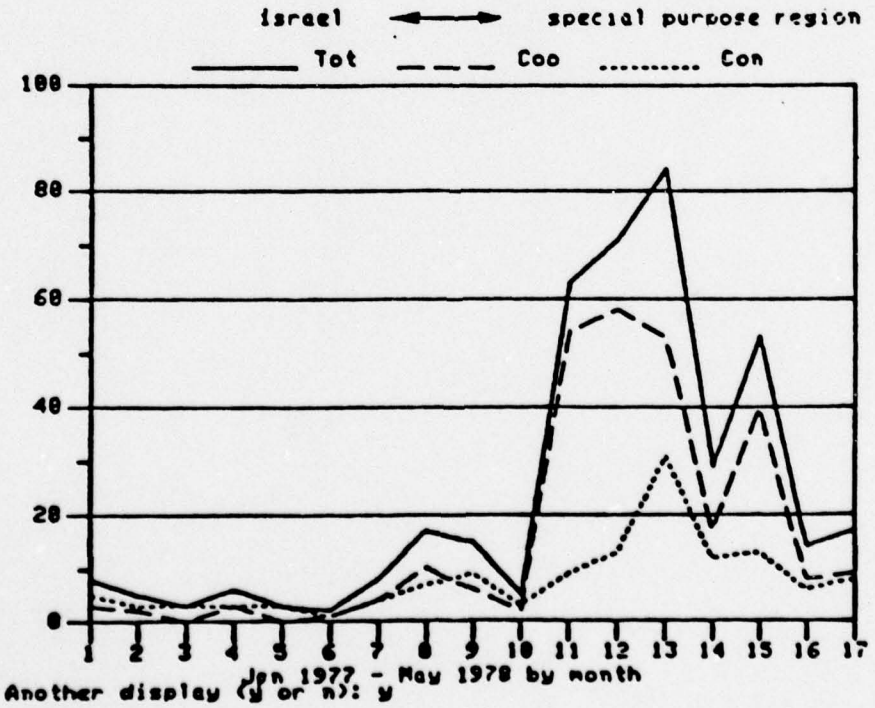
```
P R O C E S S I N G
C O M P L E T E D


Number of events found:    483
 Do you desire 30 day probablistic forecasts(y/n): y
```

Monthly Probability
Jan, 1977 - May, 1978

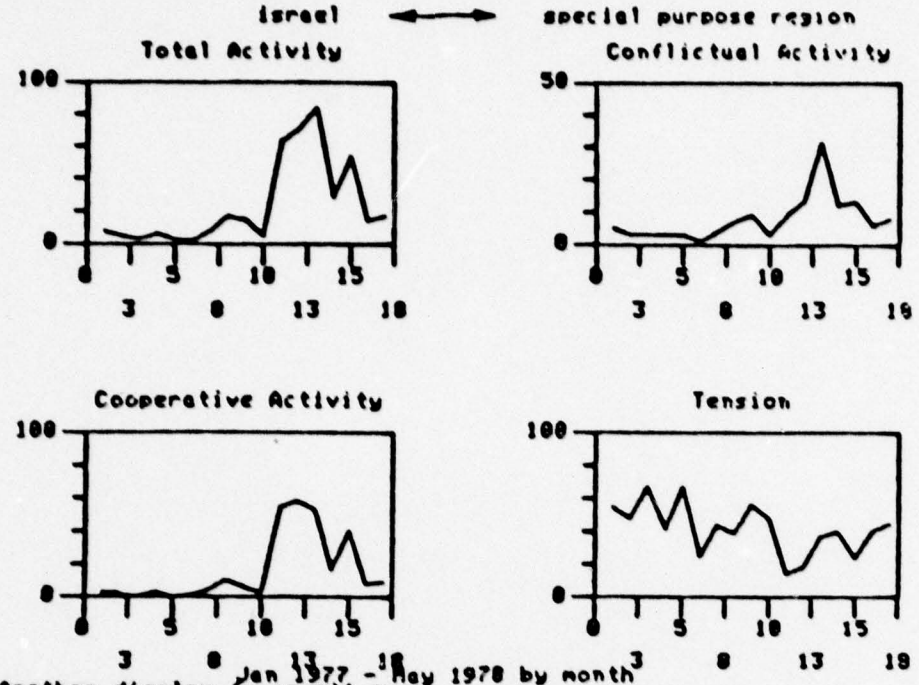
$$$ isr <<<>>> spr $$$

Date	Probability
Jan 77	.10
Feb 77	.10
Mar 77	.10
Apr 77	.10
May 77	.10
Jun 77	.10
Jul 77	.10
Aug 77	.10
Sep 77	.10
Oct 77	.10
Nov 77	.10
Dec 77	.10
Jan 78	.10
Feb 78	.10
Mar 78	.10
Apr 78	.10
May 78	.10

Press RETURN to continue:



Another display (y or n): y



Jan 1977 - May 1978 by month

Another display (y or n): n

Monthly Activity
Jan, 1977 - May, 1978

$$$ isr <<<<<< Two-Way Flow >>>>>> spr $$$

Date	Total Activity number	z-score	prob	Cooperative Activity number	z-score	prob	Conflictual Activity number	z-score	prob
Jan 77	8	-0.45	0.10	3	-0.17	0.10	5	-0.47	0.10
Feb 77	5	-0.53	0.10	2	-0.28	0.10	3	-0.53	0.10
Mar 77	3	-0.58	0.10	0	-0.50	0.10	3	-0.53	0.10
Apr 77	6	-0.49	0.10	3	-0.16	0.10	3	-0.52	0.10
May 77	3	-0.57	0.10	0	-0.50	0.10	3	-0.52	0.10
Jun 77	2	-0.59	0.10	1	-0.38	0.10	1	-0.58	0.10
Jul 77	8	-0.43	0.10	4	-0.04	0.10	4	-0.48	0.10
Aug 77	17	-0.19	0.10	10	0.64	0.15	7	-0.39	0.10
Sep 77	15	-0.24	0.10	6	0.18	0.15	9	-0.33	0.10
Oct 77	5	-0.51	0.10	2	-0.28	0.10	3	-0.51	0.10
Nov 77	63	1.04	0.16	54	5.69	0.41	9	-0.32	0.10
Dec 77	71	1.24	0.16	58	5.36	0.41	13	-0.20	0.10
Jan 78	84	1.57	0.16	53	4.29	0.41	31	0.36	0.10
Feb 78	29	0.10	0.13	17	0.94	0.15	12	-0.23	0.10
Mar 78	53	0.73	0.13	40	2.85	0.21	13	-0.20	0.10
Apr 78	14	-0.31	0.10	8	0.14	0.15	6	-0.42	0.10
May 78	17	-0.23	0.10	9	0.23	0.15	8	-0.35	0.10

Press RETURN to continue:

Monthly Tension and Uncertainty
Jan, 1977 - May, 1978

isr <<<<<< Two-Way Flow >>>>>> spr

Date	Tension	Z-score	H-rel	Z-score
Jan 77	54.7	-0.22	0.617	1.30
Feb 77	48.8	-0.43	0.431	0.38
Mar 77	66.7	0.16	0.206	-0.73
Apr 77	41.7	-0.64	0.327	-0.13
May 77	66.7	0.17	0.355	0.01
Jun 77	25.8	-1.17	0.224	-0.64
Jul 77	43.8	-0.56	0.561	1.04
Aug 77	38.8	-0.72	0.527	0.86
Sep 77	56.8	-0.15	0.506	0.75
Oct 77	48.8	-0.41	0.307	-0.25
Nov 77	14.1	-1.52	0.486	0.65
Dec 77	18.1	-1.36	0.475	0.59
Jan 78	36.5	-0.75	0.595	1.19
Feb 78	48.8	-0.63	0.401	0.20
Mar 78	24.1	-1.14	0.445	0.42
Apr 78	39.8	-0.62	0.508	0.74
May 78	44.3	-0.47	0.426	0.32

Do you want event frequencies(y/n)? n

APPENDIX B

Early Warning and Monitoring Project
List of Publications

APPENDIX B

EARLY WARNING AND MONITORING PROJECT
LIST OF PUBLICATIONS

RESEARCH MEMORANDUMS

1. Subject: Monitoring for Crisis Early Warning
   Author: Richard W. Parker
   Date: October 29, 1976

2. Subject: Usefulness of Diplomatic Exchange Data Base and Software
   Author: Richard W. Parker
   Date: November 4, 1976

3. Subject: Joystick Application
   Author: James F. Wittmeyer
   Date: November 15, 1976

4. Subject: Bayes, Blalock and Best Estimates: Hindsighting the Czech Invasion
   Author: Stephen J. Andriole
   Date: November 12, 1976

5. Subject: Support and Test Programs
   Author: James F. Wittmeyer
   Date: January 15, 1977

6. Subject: Integration and Use of Additional International Indicators
   Author: Stephen J. Andriole
   Date: January 10, 1977

7. Subject: Generation and Use of More Salient Probability Conversion Tables
   Author: Stephen J. Andriole
   Date: January 14, 1977

8. Subject: Using Economic Indicators for Crisis Monitoring and Forecasting
   Author: Richard W. Parker
   Date: March 28, 1977

9. Subject: "Correcting" Crisis Indicators
   Author: Richard W. Parker
   Date: March 28, 1977

10. Subject: All vs. All: Warning and Monitoring in the Aggregate Level
Author: Judith Ayres Daly
Date: March 7, 1977

11. Subject: Record of Miscellaneous Runs
Author: Judith Ayres Daly
Date: April 4, 1977

12. Subject: ROZ: Preliminary Tests and Analyses
Authors: Judith Ayres Daly and James F. Wittmeyer, III
Date: July 29, 1977

13. Unassigned

14. Subject: Probability Tables
Authors: Judith Ayres Daly and Brenda D. Bell
Date: August 5, 1977

15. Subject: A Preliminary Comparison of Political and Military Indicators (Classified)
Author: Judith Ayres Daly
Date: September 21, 1977

16. Subject: Weighting Tension for Improved Warning and Monitoring Performance
Authors: Judith Ayres Daly and Brenda D. Bell
Date: September 30, 1977

17. Unassigned

18. Subject: Regional Tension: A Middle East Case Study
Author: Judith Ayres Daly
Date: November 1, 1977

19. Subject: Weighting Tension: An Examination of Cell Frequencies
Author: Thomas R. Davies
Date: December 16, 1977

20. Subject: Pre-Crisis Peaks, False Alarms, and Conflict Event Types
Author: Thomas R. Davies
Date: February 15, 1978

21. Subject: Early Warning and Monitoring System Software
Author: Brenda D. Bell
Date: February 22, 1978

22. Subject: Problems of Applied Monitoring and Warning
Author: Judith Ayres Daly
Date: March 15, 1978

23. Subject: Bits about DDF
Author: Brenda D. Bell
Date: Forthcoming

24. Subject: Testing the Warning Capabilities of a New Tension Indicator
Author: Thomas R. Davies
Date: Forthcoming

JOINT RESEARCH MEMORANDUMS

1. Subject: Increasing the Sample for the Cross-National Crisis Indicators Project
Authors: Judith Ayres Daly, Decisions and Designs, Incorporated, and Gerald W. Hopple, University of Maryland
Date: October 28, 1977

TECHNICAL REPORTS

TR 76-19
Subject: Progress Report on the Development of an Integrated Crisis Warning System
Author: Stephen J. Andriole
Date: December 1976

TR 76-20
Subject: Software Design for an Interactive Crisis Early Warning Prototype System
Author: James F. Wittmeyer
Date: December 1976

TR 76-21
Subject: Crisis and Crisis Forecasting: An Analytical Review of the Literature
Author: Richard W. Parker
Date: December 1976

TR _____
Subject: Users Manual for the Early Warning and Monitoring System
Author: Thomas R. Davies
Date: Forthcoming

ANNUAL PROGRESS REPORTS

1. Subject: Crisis Early Warning and Monitoring System
Period: 1 October 1976-30 September 1977
Date: November 29, 1977

OTHER PUBLICATIONS

Articles

1. Title: Conceptualizing an Integrated Crisis Warning System
   Authors: Stephen J. Andriole and Robert A. Young
   Journal: Journal of Defense Research
   Date: Spring 1977

2. Title: The Development of a Prototype Crisis Early Warning System
   Authors: Stephen J. Andriole and Robert A. Young
   Journal: Journal of Defense Research
   Date: Spring 1977

3. Title: Toward the Development of an Integrated Crisis Warning System
   Authors: Stephen J. Andriole and Robert A. Young
   Journal: International Studies Quarterly
   Date: March 1977

4. Title: Examination of Basic and Applied International Crisis Research
   Author: Richard W. Parker
   Journal: International Studies Quarterly
   Date: March 1977

5. Title: Computers and Crisis: Monitoring and Forecasting International Political Affairs
   Author: Stephen J. Andriole, Brenda D. Bell, Judith Ayres Daly, Thomas R. Davies, James F. Wittmeyer, and Robert A. Young
   Journal: The World Future Society Bulletin
   Date: May/June 1978

Conference Papers

1. Title: Decision Process Models and the Needs of Policy-Makers: Thoughts on the Foreign Policy Interface
   Author: Stephen J. Andriole
   Conference: International Studies Association
   Place: Toronto, Canada
   Date: February 1976

2. Title: Bayes, Blalock, and Best Estimates
   Author: Stephen J. Andriole
   Conference: Southern Political Science Association
   Place: Atlanta, Georgia
   Date: November 1976

3. Title: Crisis Early Warning in a Regional Subsystem: The Middle East Case
Authors: Judith Ayres Daly and Richard W. Parker
Conference: Society for General Systems Research
Place: Denver, Colorado
Date: February 1977

4. Title: Monitoring and Forecasting International Crises: The Use of Economic Indicators
Author: Richard W. Parker
Conference: International Studies Association
Place: St. Louis, Missouri
Date: March 1977

5. Title: A Crisis Early Warning Prototype System
Author: Judith Ayres Daly
Conference: 39th MORS (Military Operations Research)
Place: Annapolis, Maryland
Date: June 1977

6. Title: Application of an Early Warning and Monitoring System: The Middle East
Author: Judith Ayres Daly
Conference: International Studies Association
Place: Washington, DC
Date: February 1978

APPENDIX C

List of Those Who Have Viewed the Early Warning and Monitoring System Demonstration

APPENDIX C

LIST OF THOSE WHO HAVE VIEWED THE EARLY WARNING AND MONITORING SYSTEM DEMONSTRATION

Government Agencies

T. Belden, Intelligence Community Staff
B. Blechman, Department of State
W. R. Broach, Defense Intelligence Agency
G. Bryan, Office of Naval Research
S. Buckley, National War College
L. Capone, Defense Communication Agency
D. A. Charvonia, Defense Advanced Research Projects Agency, Europe
S. L. D'Orazio, Defense Intelligence Agency
J. P. Duffy, Defense Intelligence Agency
R. Elliott, Department of State
L. D. Faurer, European Command (EUCOM)
J. Floyd, Defense Intelligence Agency
R. R. Fossum, Defense Advanced Research Projects Agency
R. M. Ghormley, Defense Communication Agency
M. Hayes, Defense Advanced Research Projects Agency
L. Hazlewood, Central Intelligence Agency
W. D. Henderson, Office of the Secretary of Defense
D. Howell, Department of State
J. L. Houlgate, Defense Intelligence Agency
B. B. Johnson, Defense Intelligence Agency
E. L. Johnson, Office of Naval Research
F. Kapper, Office of the Secretary of Defense
J. E. Kelly, Defense Intelligence Agency
G. W. Krieser, Defense Intelligence Agency
J. Levan, United States Air Force, Europe
H. Lobdell, National War College
D. Looft, Defense Advanced Research Projects Agency
D. Mahley, National War College
D. K. Malone, Defense Intelligence Agency

B. Marecic, Naval Postgraduate School
J. Markowitz, Central Intelligence Agency
A. Marshall, Office of the Secretary of Defense
J. A. Nagay, Office of Naval Research
C. H. Norton, Defense Intelligence Agency
J. R. Pettit, Defense Intelligence Agency
J. Robbins, Central Intelligence Agency
G. E. Ruhl, Defense Intelligence Agency
B. J. Schick, Defense Intelligence Agency
R. G. Sherwin, Naval Postgraduate School
A. Smith, Central Intelligence Agency
J. E. Snyder, Defense Intelligence Agency
V. Spoto, Office of Commander-in-Chief, Atlantic Fleet, Norfolk (CINCLANT)
J. Stark, Office of the Chief of Naval Operations
R. Winterberg, Central Intelligence Agency

Research and Development Institutions

J. Ballentine, Systems Planning Corporation
M. Ben Bassat, Perceptronics, Incorporated
W. Beyers, Mitre Corporation
A. Clarkson, Electromagnetic Systems Laboratories
M. A. Daniels, International Public Policy Research Corporation
D. Druckman, Mathtech, Incorporated
J. Fain, CACI, Incorporated
J. M. Fox, Decisions and Designs, Incorporated
R. Gerenz, Betac, Incorporated
D. Guertin, Exxon Corporation
R. Hayes, CACI, Incorporated
G. Heilmeier, Texas Instruments
G. W. Hopple, International Public Policy Research Corporation
W. Howard, Systems Planning Corporation
S. Kaplan, The Brookings Institution
C. W. Kelly, Decisions and Designs, Incorporated
B. Kelly, BDM Corporation

A. W. Kibler, Decisions and Designs, Incorporated
J. Kudzie, RCA Corporation
T. Marril, Computer Corporation of America
J. Paisley, Mitre Corporation
C. R. Peterson, Decisions and Designs, Incorporated
D. Poe, BDM Corporation
J. B. Rothnie, Computer Corporation of America
L. Russo, Exxon Corporation
W. Shawcross, Decisions and Designs, Incorporated
C. Sherbrook, Mathtech, Incorporated
R. O. Slater, Mathtech, Incorporated
A. Snyder, Computer Corporation of America
M. D. Van Orden, Decisions and Designs, Incorporated
A. R. Wagner, Analytical Assessments Corporation
G. Weltman, Perceptronics, Incorporated

Colleges and Universities

R. Butterworth, Pennsylvania State University
S. Chan, University of Maryland
W. Domke, University of Michigan
G. T. Duncan, Carnegie-Mellon University
J. Gillespie, Indiana University
B. L. Job, University of Minnesota-Twin Cities
J. Kidd, University of Maryland
J. Kringen, University of Maryland
J. Kugler, Boston University
C. A. McClelland, University of Southern California
D. McCormick, University of Maryland
W. R. Martin, California State College/Dominguez Hills
J. F. K. Organski, University of Michigan
W. Phillips, University of Maryland
P. Rossa, University of Maryland
F. Rothe, University of Southern California
P. Werbos, University of Maryland
J. Wilkenfeld, University of Maryland
D. Zinnes, Indiana University

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_____ and J. F. Wittmeyer. (1977) "ROZ: Preliminary Tests and Analyses." Early Warning and Monitoring Project, Research Memorandum #12. McLean, VA: Decisions and Designs, Incorporated, July.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This technical report documents and summarizes the progress made toward the development of a crisis early warning and monitoring system. Chapter 1 reviews the crisis warning problem and proposed solution. Chapter 2 summarizes the contract tasking and project accomplishments. The components of the early warning system and their interrelationships are detailed in Chapter 3. Chapter 4 reports on progress in developing new indicators and software capabilities. Chapter 5 documents developments made in transferring and demonstrating the prototype system. The →

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current status of the blend between empirical and decision analytic warning methodologies is described in Chapter 6. Chapter 7 outlines future research developments to be designed, tested, and integrated.

The Early Warning and Monitoring system is comprised of several main components including quantitative indicators, general scans, a forecasting methodology, and an interactive computer base. The quantitative indicators include international political indicators of activity, tension, and uncertainty. The monthly forecasts are based on extensive retrospective tests of past crisis behavior. Testing has shown that the computer-based system is capable of substantially improving the defense community's ability to forecast specific international crises.

A combination of interaction with potential users and research findings has resulted in substantial modifications to the original design of the warning and monitoring system. The quantitative political indicators have been modified, and extensive testing has resulted in higher hit rates and lower false alarm rates. Progress has been made on developing new indicators such as regional and systemic ones. Daily updated data has permitted testing on all components of the warning system in a real-time mode. Also, preliminary testing has begun focusing on comparing political and military indicators in historical crises. Finally, research on the overlap between empirical science and decision-analytic methodologies has resulted in the identification of several potential methods of integration.